Management Alternatives for New Brunswick's Public Forest

Report of the New Brunswick Task Force
on Forest Diversity and Wood Supply

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The Honourable Donald Arseneault
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Dear Minister Arseneault:

We are pleased to present to you the final report of the Task Force on Forest Diversity and Wood Supply.

Our mandate was to design forest management alternatives aimed at meeting forest diversity and wood supply objectives for New Brunswick's public forest and to characterize the probable outcomes of those alternatives in terms meaningful from environmental, economic, and social perspectives. We have addressed that mandate to the best of our ability, and with a level of effort commensurate with the great importance of New Brunswick's forest to the well-being of the Province.

We believe this report reflects a reasonable range of forest management alternatives for the New Brunswick public forest. Interested parties will vary in their views regarding what alternatives are preferable, but this report should assist them in understanding the short and long-term consequences of each alternative.

Our overarching goal with this report is to provide information that makes an important contribution in the difficult decision about how best to manage New Brunswick's forest. We hope that you and others interested in the state of our forest find that we have succeeded in our effort.

Respectfully submitted.

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We also owe a special thanks to Chris Norfolk for his thorough and accurate recording of minutes at all Task Force meetings.

Finally, we acknowledge and thank Chris Ward of the University of New Brunswick who played an instrumental role in conducting analyses, summarizing results, and assembling this report. The Task Force effort benefitted substantially from his skillful, tireless, and enthusiastic contribution.

The Task Force on Forest Diversity and Wood Supply April 2008

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Executive Summary

Report of the New Brunswick Task Force on Forest Diversity and Wood Supply

Background

In response to recommendations of the New Brunswick Select Legislative Committee on Wood Supply, the Minister of Natural Resources established in 2005 the Task Force on Forest Diversity and Wood Supply. He gave it the mandate to develop a set of realistic and practical forest management alternatives that would encompass a broad range of possible ways for managing New Brunswick's public (Crown) forest.

Each alternative was to meet two requirements:

- to generate increasing yields of a wider variety of commercial tree species and products; and
- to do so in a manner that recognizes and maintains the diversity and important ecological features of New Brunswick's Acadian forest.

Further, the probable short- and long-term outcomes of each alternative were to be fully presented using measures relevant to forest diversity, wood-based business opportunity, and socio-economic impact.

The Task Force was to deal specifically with management of the public forest, not matters of tenure, resource allocation, or private ownerships.

This report presents forest management alternatives developed by the Task Force in accordance with its mandate. By design, it contains no recommendations or judgements. Rather, it presents what can realistically be done in the public forest, and with what probable result. It is intended to promote a full awareness of alternatives and consequences, and thereby contribute in the process by which management of New Brunswick's public forest is determined.

New Brunswick Forest Context

The Acadian forest, used here in reference to the entire forest of New Brunswick, is characterized by high species richness, high diversity in forest composition and structure, and great variety in the types of natural disturbance it experiences. Human influence over the past 200 years has negatively affected several elements of this naturally diverse forest, including the abundance of late-successional tree species, complex and multi-aged stand structures, and very old and very large trees. There is risk that future management will further impact these elements resulting in simplification of the forest structure and composition. Avoidance of that risk and maintenance of key ecological aspects of the Acadian forest factored prominently in design of the management alternatives presented here.

New Brunswick's industrial wood consumption, 70% of which is spruce and balsam fir, has risen 50% over the past 30 years. At the same time, wood consumption has diversified, with increased use being made of species other than spruce and fir. Wood utilization has also changed; most harvested volume is first processed for solid wood products with residual material being used for fibre-based products. In recognition of these trends, the management alternatives presented here were designed to produce sustainable and increasing wood supplies of a variety of species in tree sizes suited to manufacturing of solid wood products.

The New Brunswick public forest today is 55% spruce and balsam fir (by volume), 14% other softwood species, and 32% hardwood species. Black spruce and balsam fir are the two most abundant species, each making up 20% of the inventory. As a result of silviculture activities started in the 1970s, 10% of the forest is currently in plantations and 11% in spaced stands of natural regeneration. Twenty percent of the forest is less than 20 years old, and an equal amount is greater than 85 years old.

Under current policy, 30% of the forest area is designated as conservation forest, where conservation objectives prevail, and 70% is classified as general forest, where timber objectives are emphasized.

The existing forest presents an opportunity to generate a diverse and high quality wood supply, and poses a challenge to do so in a way that ensures continual presence of its important ecological characteristics.

Management Design Framework

Using current inventory data, state-of-the-art forest development forecasting procedures, and input from a wide variety of experts in the fields of forestry, ecology, socio-economics, and the forest industry, eight forest management alternatives were designed using a common framework. That framework was based on seven cornerstone issues which represent key decisions in forest management and about which there are highly diverse views among parties with an interest in the New Brunswick forest.

For each cornerstone issue a range of reasonable options was defined. Management alternatives were then defined by choosing options for each of the issues in various combinations. These cornerstone issues and associated range of options are:

- Wood Supply – The tree species and tree sizes given production priority greatly influence characteristics of the forest and the wood supply it provides. All wood supply options, except the status quo, maximized volume of log-potential trees (those dimensionally-suitable as sawlogs) and sustained or increased supply over time of all species groups. Options for species priority included spruce/fir/jack pine (henceforth referred to as spruce/fir) as top priority, non-spruce/fir species as top priority, and equal priority across all species.

- Protected Areas – The forest in protected areas cannot be harvested and develops through time only as influenced by natural dynamics. It has important ecological, scientific, and social value, but is unavailable as a source of wood. Options for the percent of forest area designated as protected ranged from the current level of 4% to 22%, the latter being deemed by some conservation agencies as the amount needed to provide full ecological representation in the province.

- Area of Conservation Forest – Conservation forest has the primary objectives to maintain habitat to support wildlife populations, maintain water quality, and protect riparian and wetland habitats. Some timber harvesting is permitted, but only on a restricted and limited basis that does not compromise the conservation objectives. Options for conservation forest area included maintaining it at the current level of 30% of the forest (which includes 4% of the forest currently in protected areas), increasing it to 37%, and decreasing it to 25% and 20%.

- Old Forest – The unique physical conditions and ecological functions of old forest make it ecologically important and socially significant. Management strategies focused on wood supply frequently target old stands for harvest because of their high timber-value, and can preclude growth of stands into old forest condition. Options for the percent forest area in old forest conditions ranged from 25% to 40%.

- Area in Plantations – Plantations are highly productive sources of wood supply, but their establishment involves practises and creates conditions deemed by some as ecologically damaging or otherwise undesirable. Plantation area options ranged from reducing plantation area to zero, to increasing it to 37% of the total forest over the next 50 years.

- Harvest Treatments – The treatments, or prescriptions, by which stands are harvested shapes forest condition, controls species composition and stand structure, and affects wood supply quantity, quality, and cost. Views vary widely about the acceptability of different harvest treatments. Treatment options were defined by the stand types in which harvesting must be by non-clearcut prescriptions, and by the amount of area left permanently unharvested (termed retention) to provide structural diversity in harvested stands. Retention levels varied from 0% to 20% of stand area.

- Forest Composition – Stand types, defined by the mixture of tree species growing in association, are the building blocks of forest landscapes and their relative abundance influences both forest and wood supply diversity. Forest composition options were defined in terms of area of stand types deemed less abundant today than historically (pre-1940). Options ranged from preventing future decline of these types to increasing them to estimated past levels of abundance.

Management Alternatives

Management alternatives can be created by combining options for the seven cornerstone issues in various ways. Of the numerous such combinations, the Task Force defined eight alternatives for full analysis. These eight are not an exhaustive set and alternatives defined by other combinations of options may warrant consideration. They were chosen to cover a broad range of possibilities, and vary both in the relative emphasis given to wood supply and forest diversity objectives, and in the means by which those objectives are realized (Table ES1). All alternatives, except the status quo, ensure a steady or increasing wood supply of log-potential volume for all major tree species. In addition, all alternatives include the current silviculture budget of $24.5 million per year.

Status Quo

This alternative reflects forest management on Crown land as implemented under current government policy and includes both diversity and wood supply objectives.

Alternative A

This alternative has forest conservation as the over-riding objective, which it achieves primarily through:

- increasing protected area from the present 4% to 22%;
- increasing conservation forest area from the present 30% of the total forest to 37%;
- reducing plantation area over time to zero;
- maximizing use of non-clearcut harvesting where silviculturally appropriate and conducting all harvest treatments to maintain key within-stand characteristics as would exist following natural disturbances.

Alternative B

This alternative focuses on changing the forest condition to increase forest diversity in all its dimensions, including wood supply, species composition, stand type abundance, and amount of old forest. It does so primarily by:

- increasing protected area from 4% to 10%;
- maintaining at least 40% of the forest in old forest conditions;
- maximizing use of non-clearcut harvesting where silviculturally appropriate;
- limiting plantations to 13% of the forest area (their abundance in 2012, which is the end of the current planning cycle).

Alternative C

This alternative increases the emphasis on diversity and conservation objectives relative to the status quo and includes measures to partly offset the resulting wood supply impacts. It does so primarily by:

- increasing protected area from 4% to 13%;
- maximizing use of non-clearcut harvesting where silviculturally appropriate;
- allowing plantation area to increase to 19% over the next 50 years;
- reducing conservation forest area from 30% to 25%.

Alternative D

This alternative includes objectives to increase forest diversity, while introducing measures to mitigate the negative wood supply consequences of those objectives. Its key features include:

- increasing protected area from 4% to 13%;
- conducting non-clearcut harvesting in stands where late-successional species currently dominate;
- reducing conservation forest area from 30% to 25%;
- allowing plantation area to increase to 37% over the next 50 years.

Alternative E

This alternative reflects the recommendations of the report by the New Brunswick Task Force on Self-Sufficiency. It has the primary objective of increasing current and future wood supply. It achieves this by:

- increasing protected area from 4% to 10%, all of which is drawn from the current conservation forest so that no reduction in general forest results;
- reducing the conservation forest area from 30% to 20%;
- allowing plantation area to increase to 37% over the next 50 years;
- maintaining the current proportions of harvesting by clearcut and non-clearcut prescriptions.

Alternative F

This alternative relies on extensive application of low-intensity harvesting across the forest so that most hectares contribute to both wood supply and diversity objectives. It is in contrast to a zoning strategy (where the forest is divided into zones, each with specialized objectives). Its key elements include:

- maximizing use of non-clearcut harvesting where silviculturally appropriate and conducting all harvest treatments to maintain key within-stand characteristics as would exist following natural disturbances;
- retaining 10% to 20% of each harvested stand in a permanently unharvested state (including areas to be planted);
- with the exception of protected areas, riparian buffers, and deer wintering areas, making all conservation forest eligible for low intensity harvest prescriptions;
- allowing plantation area to increase to 25% of the forest.

Alternative G

This alternative uses specialized zones; one to provide diversity values; one to provide wood supply values; and one to provide both. It combines the benefits of single-objective management in the first two zones with those of multiple-objective management in the third. It includes:

- increasing protected area from 4% to 16%;
- maintaining conservation forest at 30%;
- allocating 25% of the forest to intensive management of plantations established on sites of above average productivity;
- managing the balance of the forest with low-intensity prescriptions, which include non-clearcut harvesting in all eligible types, and permanent within-stand retention of 10% to 20% in all harvested areas.

Table ES1 – Summary of alternative forest management strategies defined by selected options for each of seven cornerstone issues.

Alternative	Wood Supply Priority	Protected Area (%)[1]	Conservation Area (%)[1,3]	Minimum Old Forest Area (%)[2]	Maximum Plantation Area (%)[1]	Harvest Treatments	Forest Composition
SQ	spruce/fir	4	30	25[5]	25	non-clearcutting where late-successional species individually >50% (current policy)	maintain vegetation communities[4]
A	equal	22	37	40	0	emulate natural disturbance	restore under-represented types
B	equal	10	30	40	13	restore late-successional species by non-clearcutting where their combined content >20%	increase under-represented types to above 1940 levels
C	spruce/fir	13	25	25	19	restore late-successional species by non-clearcutting where their combined content >20%	restore under-represented types
D	spruce/fir	13	25	25[5]	37	maintain late-successional species by non-clearcutting where their combined content >50%	maintain under-represented types
E	spruce/fir	10	20	25[5]	37	non-clearcutting where late-successional species individually >50% (current policy)	maintain vegetation communities[4]
F	equal	10	20	25[5]	25[6]	emulate natural disturbance	maintain vegetation communities[4]
G	spruce/fir	16	30	25[5]	25	emulate natural disturbance	maintain under-represented types

1. Expressed as percent of the total Crown forest area of 2.99 million ha.
2. Species classified as "late successional" in this report include cedar, hemlock, red spruce, white pine, sugar maple, and yellow birch. Percentages based on stand volume.
3. Includes protected area.
4. Vegetation communities, which are groups of stand types defined by species composition, are the basis for objectives used in current management strategies.
5. These alternatives are based on the status quo and thus have no explicit old forest targets as old forest is defined in this report. As a result of other objectives old forest is maintained at or above 25% of the forest.
6. Gross plantation area is set at 25%, but under this alternative 10% of all harvest areas is left as permanent retention; thus actual area planted equals 22.5% of total forest.

Management Outcomes

Using state-of-the-art forecasting models, forest development was forecast for each alternative over a 100-year time horizon. The resulting outcomes were characterized by a set of indicators relating to forest diversity, wood-based business opportunity, and socio-economic impacts. These indicators were selected with input from numerous professionals, practitioners, and others knowledgeable in these three subject areas. The analyses performed here did not include spatial lay-out, operational net-down, and other detailed procedures employed in developing management plans for implementation on Crown licenses. As a result, the absolute wood supply levels can not be compared to those in Licensees' management plans or to timber allocations derived from them. The analyses should, however, accurately reveal relative differences in outcomes between alternatives and provide a sound basis for evaluating their relative merits (Table ES2).

Wood Supply – Spruce/fir

Only alternative E produces a sustainable wood supply of log-potential spruce/fir above that of the status quo in the short-term (next 25 years). It does so primarily by reducing area in conservation forest, which makes more area available for harvest.

The other six alternatives (A, B, C, D, F, G) produce less in the short-term than the status quo, because they increase one or more of the following as a means of achieving forest diversity values:

- retention of unharvested patches in harvested stands;
- amount of protected area;
- use of non-clearcut treatments;
- amount of old forest condition.

The greater the levels of these factors, the lower the spruce/fir supply; thus, of these six alterntatives, A and B produce the lowest log-potential supply (at 62% of the status quo), and F and D the most (at 99% and 94% of the status quo, respectively).

The short-term wood supply is constrained by a minimum inventory level forecast to occur within the next 20 years. After that point, the spruce/fir wood supply increases. That increase is greatest, and wood supply doubles in the long-term, under alternatives D and E. The long-term spruce/fir supply is a direct function of the yield and area of plantations, and these two alternatives have the highest plantation area (37% of the total forest). Future spruce/fir wood supply is the lowest under alternative A, because it allows no planting.

Wood Supply - Other Species

The status quo results in the highest short-term supply of cedar, white pine, intolerant hardwood, and poplar, but the log-potential wood supply of each declines in the future because the status quo contains no sustainability objectives for wood supply of these particular species.

All other alternatives produce sustainable, non-declining wood supply of all major species groups, including spruce/fir, white pine, cedar, tolerant hardwood (sugar maple and yellow birch), intolerant hardwood (red maple and white birch), and poplar. This reduces the immediate supply of each to ensure long-term sustainability and has a negative effect on short-term spruce/fir wood supply of approximately 4%, as it restricts harvesting in some mixed stands that would otherwise be harvested to capture their spruce/fir content.

Excluding the status quo, the supply of cedar and white pine is highest in both the short-term and long-terms under alternatives E and F, because they reduce conservation forest area. Long-term supply of pine is favoured with planting, because pine is part of the standard planting mix; thus, the future pine supply increases most under alternatives with high planting levels. Because of its relatively slow growth and limited silviculture options, cedar shows only modest increases in supply (6-14%) over the long-term under all alternatives.

The supply of tolerant hardwood is sustainable under the status quo because of the long-standing tolerant hardwood policy for Crown licenses. It is highest in the short-term under alternative E because of the reduced area of conservation forest. In general, the long-term log-potential supply varies relatively little across alternatives because all include the tolerant hardwood policy of the status quo; however, the long-term supply under alternative B is highest because it includes objectives to increase the future abundance of stand types in which tolerant hardwood is a main component.

Intolerant hardwood and poplar log-potential supplies are highest under alternatives E and F, and lowest under A and B, primarily because of the land allocation to conservation forest under those alternatives. Under the status quo, which has no objectives to sustain wood supply of intolerant hardwood and poplar, the log-potential supply of these species drops by approximately 50% in the long-term. Under the other seven alternatives, supplies of poplar and intolerant hardwood are sustained, but do not increase. Increasing the wood supply of these species, and therefore their content in the forest, was seen as

Table ES2 – Summary of selected outcomes under eight forest management alternatives for New Brunswick Crown forest.

	Indicator and Units	Alternative[1]							
		SQ	A	B	C	D	E	F	G
WOOD SUPPLY	Spruce/fir Log-Potential[2] (million m³/yr)	2.7 4.2	1.7 2.2	1.7 2.3	2.3 3.5	2.5 5.1	2.8 5.3	2.6 4.4	2.5 4.8
	Spruce/fir Total[2] (million m³/yr)	4.0 6.1	2.5 3.1	2.7 3.4	3.6 5.1	3.8 7.0	4.2 7.3	3.9 6.1	3.7 6.8
	Other Softwood Log-Potential[2] (thousand m³/yr)								
	Cedar	89 39	43 49	35 39	62 69	60 66	72 76	75 83	62 68
	White Pine	133 128	67 136	51 112	95 141	118 189	130 200	131 212	113 173
	Other Softwood Total[2] (thousand m³/yr)								
	Cedar	146 58	70 70	55 55	99 99	96 96	113 113	119 119	98 98
	White Pine	229 349	125 300	101 266	174 372	196 469	212 478	207 546	187 455
	Hardwood Log-Potential[2] (thousand m³/yr)								
	Sugar Maple and Yellow Birch	210 239	129 217	171 320	183 261	202 270	246 278	212 270	202 233
	White Birch and Red Maple	234 110	113 127	128 170	158 158	158 158	179 179	171 171	159 159
	Poplar	194 75	90 90	86 107	111 111	113 113	132 132	117 117	105 105
	Hardwood Total[2] (thousand m³/yr)								
	Sugar Maple and Yellow Birch	417 662	259 490	326 661	348 526	373 535	451 542	392 570	377 496
	White Birch and Red Maple	848 603	453 499	503 585	615 627	608 608	677 677	650 669	608 616
	Poplar	386 384	198 218	193 237	240 303	242 270	279 306	245 317	229 282
	Wood Cost ($/m³ for years 1-25 in constant dollars)	43.3	44.5	44.9	44.6	45.1	43.7	45.7	44.8
	Land Allocation (% of total forest area)[3]								
	General forest	68	62	68	75	75	79	82	72
	Protected natural area (PNA)	4	22	10	13	13	10	10	16
	Conservation forest outside PNA	28	16	22	12	12	11	8	12
	Forest Condition (% total forest area in 2062)								
	Even-aged Planted[4]	22	5	13	19	37	37	23	23
	Spaced	21	29	25	23	9	8	22	22
	No silviculture treatment	27	25	20	21	23	27	21	22
	Uneven-aged (created by harvest)	7	12	16	16	10	9	19	10
	Unmanipulated	23	29	26	21	21	19	15	23
	Old Forest (% of total forest area in 2062)	34	49	51	34	33	31	37	34
	Forest Composition[5] (% of total forest area in 2092)								
	Fir and Spruce/fir	54	53	41	47	49	52	51	52
	Tolerant (pure and mixed)	21	26	37	30	25	23	26	24
	Pine (combined)	4	4	6	5	6	6	4	4
	Intolerant Mixed wood	21	17	16	18	20	19	19	20
	Area clearcut (% of total area harvested over years 1-25)	81	49	52	50	66	72	45	63
	Natural Disturbance-based Harvest (% of total area harvested over years 1-25)	23	100	58	63	40	34	100	73
	Employment[6] (jobs/yr)	7600	3900	4000	6000	6500	7200	6700	6300
	Value of Shipments[6] (billion $/yr)	1.44	0.72	0.72	1.07	1.14	1.30	1.19	1.11
	Contribution to GDP[6] (billion $/yr)	0.80	0.40	0.40	0.59	0.64	0.72	0.66	0.62
	Royalties[6] (million $/yr)	61	31	30	48	53	60	55	51

1. Highest values for each indicator are in bold, lowest values are underlined.
2. Left value in cell is average for years 1-25, right value is average for years 26-100. Higher precision in values is used for calculating percentages stated in text.
3. Stand types are described in more detail in main text.
4. Land allocation to conservation forest varies slightly from the options defined for some alternatives because of inoperable forest and non-spatial inventory compilation.
5. Plantation area changes through time in accordance with limits for each alternative; limits are not met until after year 50 for some alternatives.
6. Average for years 1-10 (in constant dollars).

conflicting with diversity objectives for the Acadian forest, so no objectives to increase them were employed.

It is important to note that although the eight management alternatives vary significantly in terms of the harvest and silviculture treatments employed, the resulting impacts on wood supply from the treated stands will not materialize for at least 25 years. The greatest determinants of immediate wood supply of all species are decisions that govern availability of stands for harvest today, most notably the amount of non-clearcut harvesting and the amount of area allocated to the general and conservation forest.

Wood Cost

Wood costs increase 6% across alternatives from a low of $43.3/m^3 under the status quo to a high of $45.7/m^3 under alternative F. Since clearcutting is the lowest cost harvest prescription, wood costs generally increase with the amount of harvesting conducted by non-clearcut methods.

Land Allocation

The allocation of land to general forest and conservation forest zones is a key determinant of outcomes because of the differing objectives and treatment possibilities defined for each zone.

The protected area and conservation area options defined for each alternative directly determined the allocation of area to forest zones. The conservation forest was set highest under alternative A (37% of the total forest), and set lowest under F and E (18% and 21%, respectively). Consequently, the area of general forest was set highest under alternatives F and F (82% and 79%, respectively) and set lowest under A (62%).

The amount of forest allocated to protected area (a subset of the conservation forest) was also set highest under alternative A (22%), which has the objective of providing full representation of forest conditions in a protected area network. Protected area was set lowest under the status quo, at 4% of the total forest area. Protected area under all other alternatives was set at levels between these two extremes.

Forest Condition

The forecast future forest conditions are a combined result of land allocation, harvest treatment, and old forest options of each management alternative and vary significantly between alternatives.

Future forest conditions (described at year 50 of the 100 year forecasts) under alternatives D and E are similar and most strongly reflect the imprint of management for timber objectives. The forest area under each is approximately 37% plantations and 8% spacings. Stands managed by uneven-aged harvesting make up approximately 10% of the forest, and stands unmanipulated by any management activities make up 20%. These two alternatives result in the lowest area in old forest condition, just over 30% of the total forest area.

The status quo forest condition is similar to that resulting under alternatives D and E, except it contains less area in plantations (22%), more in spacings (21%), and slightly more in unmanipulated condition (23%).

The forest conditions resulting under alternatives A and B show the least impacts of active management. At year 50 the forest is forecasted to contain 29% and 26% unmanipulated forest, respectively, which is the most of any alternatives. They also contain the least area in plantations, 5% and 13%, respectively, and the most area in old forest condition, approximately 50% under both alternatives.

Alternative C results in the most even distribution of forest conditions, with plantations, spacings, untreated even-aged, uneven-aged stands, and unmanipulated stands each making up approximately one-fifth of the forest area.

The extensive application of low intensity management under alternative F creates a much different forest condition. It contains the least area of unmanipulated forest at forecast year 50 (15%) and the most in stands undergoing uneven-aged management (19%).

The forest condition under alternative G clearly reveals the impact of its zoning structure. It is unique amongst alternatives, in that its two dominant forest conditions

represent the two extremes of management intensity; plantations and unmanipulated forest each make up approximately 23% of the forest area.

Forest Composition

The forest composition, defined by the abundance of tree species growing in various mixtures, is heavily influenced by harvest and silviculture prescriptions, but their effect on the overall forest composition emerges only gradually over time, as more and more hectares are affected by those prescriptions.

Generally, increased use of non-clearcut treatments favours regeneration and development of shade tolerant tree species, those being ones adapted to grow in the low light conditions that exist under a canopy. Thus, alternatives with greatest use of non-clearcut treatments, like B and C, result in the highest area of stand types dominated by tolerant species (37% and 30% at year 50, respectively); those with least use of such treatments, like E and the status quo, result in the lowest abundance of such types.

A high or increasing content of intolerant species is generally viewed as inconsistent with the natural character of the Acadian forest, and except under the status quo, the abundance of stands dominated by intolerant species is kept at or below 20% of the total forest area.

Wildlife Habitats

The four alternatives with 30% or more area designated as conservation forest maintain habitat at levels deemed necessary by provincial biologists to maintain viable populations of native vertebrate species and desired populations of selected species (e.g. deer).

Reducing the conservation forest area, with no change in management of the general forest, will reduce abundance of some habitat types, which in turn, may reduce populations of species which require those types. Any impacts on populations will likely relate directly to the reduction in conservation forest area; thus, potential negative wildlife population effects of reduced conservation forest will be least under alternatives C and D, which set conservation forest area at 25%, and most under alternative E, which sets conservation forest area at 20%. Which species are most affected will depend upon what specific areas are reclassified from conservation to general forest status and exactly how the general forest is managed.

Reducing the conservation forest area under alternative F may have no negative impacts on population levels, because the low intensity harvesting extensively applied across the forest was designed to maintain habitat-suitable conditions in partially harvested areas. Confirmation that negative impacts are unlikely under this alternative will require closer investigation by wildlife habitat experts within the Department of Natural Resources.

Old Forest

Old forest conditions, which make up roughly 45% of the forest today, drop over the next 50 years as a result of harvesting under six of the alternatives. Old forest at year 50 drops to the lowest levels under alternatives E (31%) and D (33%) and falls between 34% and 37% of the total forest under the status quo and alternatives C, F, and G. Alternatives A and B result in a future increase in old forest area, which, respectively, reaches 49% and 51% of the forest area at forecast year 50.

Harvest Treatments

The amount and types of forest harvested by clearcutting has both ecological and social significance. The area clearcut as a percent of total area harvested in the first 25 years ranges across alternatives from a high of 81% under the status quo, to a low of 45% under alternative F. As clearcutting is required to prepare sites for conventional planting, alternatives with high plantation areas generally include more clearcut harvesting (e.g. D and E). Clearcutting tends to hinder regeneration and growth of shade tolerant and late-successional tree species, thus alternatives with high objectives for those species result in less clearcut harvesting (e.g. A, B, C).

A predominate view in forest ecology is that diversity can best be maintained in the forest if harvesting is conducted in accordance with the natural disturbances stands are prone to experience. This means harvesting so that post-harvest stand conditions retain some of the key elements stands possess following natural disturbances.

Such "natural disturbance-based" harvest prescriptions were defined for all stand types and the higher the percent area harvested according to those prescriptions, the higher the likelihood natural forest diversity will be maintained. Under two alternatives, A and F, 100% of the harvest area was by these disturbance-based prescriptions. The percent was lowest under the status quo (23%) and alternative E (34%) and intermediate under B (58%), C (63%), and G (73%).

Socio-Economic Impact Related to Wood Supply

Economic consequences of management alternatives are highly important, but given changes in the forest industry and forest products markets, forecasting those consequences is exceedingly difficult. To provide some basis for comparing alternatives, short-term (10 years) forecasts were made of four socio-economic indicators related to wood products manufacturing: direct employment, value of shipments, contribution to gross domestic product, and royalties paid to government.

These were based on current trends in employment and prices, assume full utilization of available wood supply, and consider wood processing only to the point of pulp, lumber, and veneer production. Down stream, value added manufacturing (e.g. paper and engineered wood products), the opportunities for which are shaped by available wood supply, is largely in the realm of industrial strategy, and was not addressed in this examination of forest management alternatives. All economic and employment indicators are based on production only from Crown land. They therefore represent only a portion of the total levels, which would include production from all private lands.

No economic indicators were assessed beyond the short-term (10 years). Instead, the characteristics of the forecast wood supply (quantity, quality, and species make-up) should provide a basis for making inferences about longer term wood supply-related socio-economic impacts and opportunities resulting from the management alternatives.

All four economic indicators vary 2-fold across the range of alternatives, and the ranking of alternatives remains essentially the same across alternatives.

The status quo alternative produces the highest levels of employment (7600 jobs, 1128 of which are seasonal silviculture jobs), shipment value ($1.44 billion/yr), GDP contribution ($0.80 billion/yr), and royalties ($61 million/yr) over the next 10 years (in constant dollars). This results because of the relatively high spruce/fir wood supply, and because of a short-term (and unsustainable) harvest of other species made possible by the absence of a sustainability objective for those species.

Alternative E is next highest for all four economic indicators because of the reduced area of conservation forest and resulting higher harvest. The economic indicator values drop as increasing emphasis is placed on forest diversity and conservation objectives. For this reason the economic indicators fall to the lowest levels under alternatives A and B.

Important Considerations

Interpolation of Other Alternatives

Eight management alternatives are presented in detail in this report, however, numerous others can be defined by combining the options for the seven cornerstone issues in various ways. Should any of these other possibilities be of interest, their probable consequences can be inferred from the cause-effect relationships presented in Part 4 of this report.

Catastrophic Loss

None of the analyses include accounting for catastrophic loss, as might be caused by wildfire, insect outbreaks, or windstorm. The assumption was made that New Brunswick will continue its relatively effective forest protection programs, and in the event major losses do occur, they will be addressed by salvage harvesting and revision of management plans as is current practise.

Climate Change

Climate change has the potential to significantly impact the forest. Given the complexity and uncertainty surrounding climate change and its impacts, it was only indirectly

addressed in the management alternatives, by controlling the abundance of tree species deemed by the scientific community as best adapted to the expected changes in climate. Changes in tree growth rates, fire and pest incidence, and regeneration patterns are expected to occur, although gradually over time. Under any management alternative, the forestry community must be alert to such changes and ready to revise management strategies as understanding of climate change impacts improves.

Unquantified Impacts

Given the Task Force mandate, socio-economic impacts addressed here relate only to wood products manufacturing. But the forest provides other economic benefits which should be considered when evaluating alternatives, such as those relating to eco-tourism, consumptive and non-consumptive recreation, and non-timber forest products. Further, there are important social implications of management that cannot readily be addressed by objective measures. Such matters include aesthetics, spirituality, and perception of risk.

To a limited extent, impacts on these socio-economic dimensions can be inferred from the forest conditions forecast under each alternative. However, more complete and explicit consideration of them should be made when evaluating the desirability of various alternatives.

The effect on ecological services provided by the forest is another important consideration in evaluating alternatives. Inferences about some such services, for example, maintenance of diversity, provision of habitat, and protection of water, can be readily made from the provided descriptions of management outcomes. Others, like water and air purification, water regime regulation, and nutrient cycling, are not directly addressed, but the variation in impacts between alternatives is tempered by the fact that all alternatives retain the same forested land area and all involve ongoing maintenance and regeneration of forest cover.

Management Flexibility

Consideration of the future necessitates use of forecasts, despite the presence of many unavoidable uncertainties and unknowns relating to economic conditions, environmental conditions, forest products markets, and social values and preferences. Adaptation to changes in these factors is partly accommodated in forest management by regular and frequent replanning in which strategy adjustments are made in response to unfolding reality.

The ability to adapt to change is partly governed by the degree of flexibility afforded by the forest condition. There is no one forest condition that all parties would agree provides maximum flexibility. Regardless, the inevitability of unpredictable change makes thoughtful consideration of management flexibility a necessary part of responsible decision-making about forest management.

Trade-offs

Finally, few would disagree that the overarching forest management objective in New Brunswick is to act now to create a forest that will be economically valuable, ecologically healthy, and socially desirable in the future, while deriving economic, environmental and social benefit from the forest today. But there is no one right way to accomplish this.

As revealed in this report, not all benefits can be simultaneously maximized; measures to enhance some benefits will negatively affect others. The resulting trade-offs cannot be avoided but they should be explicitly recognized, and consciously factored into management decisions. The decision-making challenge is to thoroughly evaluate possibilities and implement a management strategy that provides the best balance of benefits through time. The Task Force hopes this report assists the Province in that important and formidable task.

Part 1
Introduction

Report of the New Brunswick Task Force
on Forest Diversity and Wood Supply

Background

The forest is critically important to the social, economic, and environmental well-being of New Brunswick. It provides a source of employment and wealth-creation; it provides a setting for recreational and spiritual fulfilment; it performs a myriad of ecological services and functions; and it harbours thousands of plant and animal species. But just as there are many ways in which the forest is important to New Brunswick, there are many views held by New Brunswickers about how and for what the forest should be managed. Perhaps never has this diversity of views been more evident than over the past six years.

In 2002, concern about shrinking wood supplies and future competitiveness prompted the New Brunswick government and forest industry to commission international forestry consultant Jaakko Poyry to evaluate the Province's forest management policies and practices relative to other jurisdictions, and to recommend ways to create a brighter future for industrial forestry. The consultant's report put forth a number of measures for creating that future.

A vigorous debate about these measures ensued, revealing a pronounced lack of consensus about forest management in the province. This led the provincial government in 2003 to establish an all-party Select Committee on Wood Supply which was given the mandate to examine "opportunities and strategies for the future direction of Crown forest management". The Select Committee held numerous public hearings with overflow attendance; it heard from stakeholders, interest groups, concerned citizens of all persuasions, and from experts in all aspects of forestry.

In fall 2004 the Select Committee released its findings in a report that contained four sets of recommendations comprising issues of governance, resource allocation, wood supply, and forest management. Each set was founded on a set of principles deemed by the Select Committee to have universal acceptance. Noteworthy among the principles with respect to forest management was the following: "There exist many possible future forests....and responsible decision-making requires full consideration of those possibilities prior to choice of action".[1]

While this principle seems sound and irrefutably logical, it has not seen full application in the province, simply because, to date, no comprehensive picture of New Brunswick's many forest management possibilities has been assembled or publicly aired. Absence of a full and common view of forest management alternatives, and their likely consequences, has made the decision of how best to manage the public forest a difficult one.

The public forest is a public asset and choice about its management should be a public prerogative, exercised with reference to a scientifically sound package of information about forest management alternatives; one that reflects best practice in the forest, that is based on best current understanding of how the forest functions, and that contains a full accounting of probable consequences. This report, prepared by the Task Force on Forest Diversity and Wood Supply, attempts to provide that information.

By design, it contains no recommendations or judgements, and adopts no advocacy positions. Rather, it presents what can realistically be done in the public forest and with what probable result. That information, seen by the Select Committee as a prerequisite to responsible decision-making, is intended to help New Brunswickers make an informed choice about how best to manage the forest for the benefit of present and future generations.

Task Force Mandate

In its report, the Legislative Select Committee on Wood Supply made the following two recommendations.[1]

- Recommendation 10 – DNR establish a process to develop quantifiable wood supply objectives for all commercial tree species.

- Recommendation 11 – The wood supply strategies and objectives identified above be developed with reference to the natural diversity of the Acadian forest in order to generate increasing yields of a wider variety of commercial tree species while maintaining important ecological features of the forest.

The Minister of Natural Resources struck the Task Force on Forest Diversity and Wood Supply to address the process and strategies referred to in these recommendations. More specifically, he gave it the mandate to "develop a broad set of realistic and practical forest management alternatives for Crown Land that fulfill the intent of the Select Committee's Recommendations 10 and 11" and to "reveal the probable consequences of those alternatives in terms relevant to forest diversity, wood-based business opportunity, and the socio-economic environment in a manner which clearly reveals trade-offs between alternatives".[2]

The Task Force was directed to consider only Crown (public) land, not industrial freehold or private woodlots; and to address management of the forest, not issues of tenure, administration, or resource allocation. Its work was to be completed by the end of 2007 so the findings could be incorporated in the government's decision-making process leading up to its planned 2009 policy document which will contain detailed management objectives for the Crown forest.

Process

The Task Force comprises nine individuals selected by the Minister (Appendix 1). Each brings a unique perspective and set of values relating to forestry; and each is well-positioned to understand the views of the interest groups or organizations with whom they are affiliated.

To ensure its findings would be sound and defensible, the Task Force employed the best available information and analysis tools, and sought independent outside expertise to strengthen its analysis (Appendix 2). The following specific measures were taken in this regard.

- Workshops were held with knowledgeable people in the areas of forest diversity, wood-based business enterprises, and socio-economics to identify meaningful measures of forest management outcomes.

- Experts in the New Brunswick Department of Natural Resources (DNR), the University of New Brunswick, and the Canadian Forest Service were enlisted to prepare information necessary for the analysis and to develop the economic dimensions of the analysis.

- Up-to-date forest inventory information was assembled and combined with state-of-the-art forecasting models to explore forest development under various management alternatives.

- Recognized experts were engaged to review the technical underpinnings of the analysis including those relating to stand growth, harvest and silviculture prescriptions, management alternatives, and forecasting methods.

Senior staff in the Department of Natural Resources were kept apprised of the Task Force's progress at all stages of the work. They responded to questions posed by the Task Force, but allowed it to work freely and independently, and exerted no direct influence over any aspects of the Task Force effort.

The Minister's Provincial Forest Advisory Committee was provided regular updates on progress, and sessions were held to inform the forest industry and non-governmental agencies about the nature and purpose of the work.

Report Structure‡

The balance of this report presents the findings of the Task Force on Forest Diversity and Wood Supply. Part 2 sets the stage with a brief discussion of the Acadian Forest, New Brunswick's wood supply situation, and the state of the public forest today.

Part 3 describes the framework and methods employed in designing management alternatives and for characterizing their outcomes.

Part 4 illustrates the cause-and-effect connections between management choices and outcomes to assist the reader in understanding how key management decisions affect forest diversity and wood supply.

Part 5 builds on this foundation and presents, compares, and discusses eight management alternatives for the public forest.

Part 6 presents sensitivity analyses of key management choices and uncertainties.

Part 7 highlights important considerations that should be made when interpreting the Task Force findings.

‡ Technical terms are avoided where possible, but are frequently required to convey clear meaning. Such terms are underlined and defined in the glossary.

Part 2
Setting the Stage

Report of the New Brunswick Task Force
on Forest Diversity and Wood Supply

The Acadian Forest

The Acadian Forest is the name given to the forest region which encompasses northern Maine and most of the Maritime provinces (Fig. 2-1). For simplicity, the term will be used here to refer to the entire New Brunswick forest.

The Acadian forest is a transitional one that lies between the boreal forest to the north and the deciduous forest to the south and west of New Brunswick.[1] Situated in this transitional zone, the Acadian forest has a unique set of climatic influences, geophysical variation, and natural disturbance forces which, in combination, give rise to the high degree of biological diversity that characterizes it. That diversity exists at several levels.

The forest is highly diverse in tree species composition, containing some 20 commercial tree species present in various abundance.

It is highly diverse in the degree of species intermixing which results in stand conditions ranging from pure tolerant hardwoods, to mixes of hardwood and softwood species in various combinations, to stands of near-pure balsam fir, black spruce, or jack pine.

It is also diverse in terms of within-stand structure, with some stands being highly uniform in tree size and age, and others being highly complex, containing trees of a wide variety of sizes and ages. This structural variation results from the interaction of existing species, geophysical conditions, and natural disturbances (like wind, insect, fire, and disease) which kill trees and create opportunity for establishment and growth of new trees in their place.

Natural forces and human influence have changed the Acadian forest significantly over time.[1] It has never been in a static state and it is thus impossible to specify any one set of conditions that fully characterize it.

However, based on historical accounts, research studies, and analysis of the current forest condition, there is general agreement within the forestry and ecology communities that, in addition to the high degree of diversity noted above, important ecological features of the native Acadian forest include the following:

- There exists an ecological and geophysical connection between the natural disturbances likely to occur and the stand types likely to result from those disturbances. In very general terms, some parts of the province are prone to larger scale stand replacing disturbances, caused by fire and spruce budworm; others are more prone to smaller scale gap replacing disturbances, caused by old-age, disease and windthrow; and still others experience both in various relative amounts[1] (Fig. 2-2).

- The forest areas prone to gap disturbances are typically dominated by late-successional tree species, growing in multi-aged stands. These are shaped by relatively

Fig 2-1 – Location of the Acadian forest region in Canada

(derived from Forest Regions of Canada, I.S. Rowe, 1972, Canadian Forestry Service Pub. 1300)

frequent, small scale disturbances - the death of one or a small group of trees - creating small gaps in the canopy which favour development of species which grow well in low light levels.

- Many stands contain ecological legacies, in the form of large live, dead, and fallen trees, which are important structural elements that persist in stands as they undergo natural processes of maturation, senescence, and renewal.

- Many stands contain trees of very large dimension, at ages approaching their natural maximum longevity. This is well-evidenced by the legendary New Brunswick white pine and red spruce prized for shipbuilding centuries ago.

While there may not be consensus about the magnitude or consequences of human-induced change, few would deny that management has in the past, and may in the future, impact these characteristics of the Acadian forest in a number of important ways.

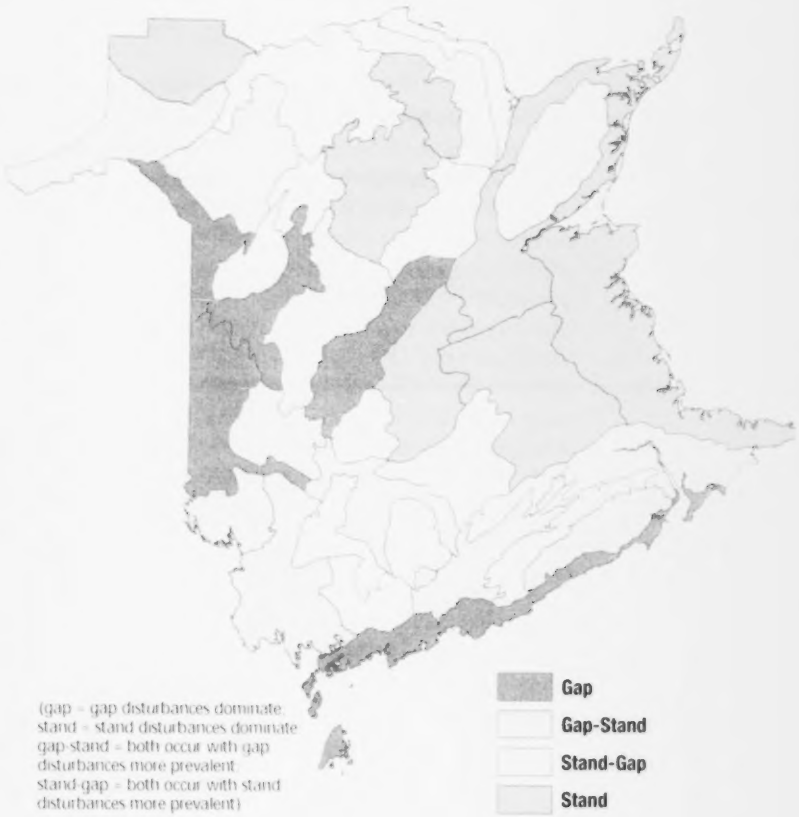
- Indiscriminate use of harvesting and silviculture treatments can create very different stand types than would naturally occur given the natural disturbance tendency of an area.

- Even when ecologically appropriate prescriptions are matched to stand types, harvesting can eliminate residual live and dead trees, leaving few of the legacy structures which play important ecological roles in the newly regenerating stand conditions.

- High harvest rates can shorten rotations, and reduce the number of trees in the forest which reach advanced ages and attain large dimensions.

These management effects can simplify the Acadian forest – reducing the richness of species, reducing the complexity of stand structures, and reducing the range of trees sizes and age - and thus compromise the essence of its natural character.

Fig 2-2 – General occurrence of natural disturbance types in New Brunswick.



(gap = gap disturbances dominate;
stand = stand disturbances dominate
gap-stand = both occur with gap disturbances more prevalent;
stand-gap = both occur with stand disturbances more prevalent)

The challenge posed by the Select Committee's Recommendation 11 is to design management alternatives which avoid this threat of simplification and which retain these important ecological features at acceptable levels.

However, because there is no single, science-based, unequivocal standard that defines "acceptable", the Task Force presents in Part 5 of this report a set of management alternatives that retains these features over a range of levels so that interested parties can evaluate some of the possibilities that exist.

Provincial Wood Supply and Consumption

Consumption

New Brunswick has a 300-year history of harvesting wood for commercial purposes. The pattern of harvesting began in the early 1700s with harvesting of white pine for ship construction. As the pine resource dwindled, spruce increased in importance and in the mid-1800s the harvest of pine and spruce supported some 600 sawmills in the province.[5] At the same time, hemlock was heavily harvested, primarily to provide tannin from its bark for the tanning industry.

Pulpmills were first constructed around the turn of the 20th century and increased in number and consumptive demand over the ensuing decades. As the pulp industry developed, balsam fir became an important economic species. Hardwood species also became more important, particularly high quality yellow birch and sugar maple, which were cut for veneer and lumber. The early 1970s brought the first hardwood pulpmill, which created the first significant industrial market for low quality hardwood.

Throughout this period of commercial forest use, the harvest rate of large trees surpassed the rate of replenishment, with a resulting decline in the average size of tree harvested.

The more recent past reveals continued changes in wood consumption patterns which have direct relevance to forest management decision-making today. The industry has shown persistent growth in wood consumption; over the last three decades total industrial consumption in New Brunswick from all sources has risen some 50%, from 8 to 12 million m /yr (Fig. 2-3).

Interestingly, none of this increase has come from the domestic spruce/fir supply, which has been harvested at the maximum sustainable level over this period. Instead, the increased consumption has been sustained by increased imports, which have tripled from 8% to 24% of total consumption over this period (Fig. 2-4), and by increased use of other species. Both hardwood and cedar consumption have nearly tripled in the last three decades, with hardwood rising from 1 to 3 million m³/yr (Fig. 2-5) and cedar from 0.1 to 0.3 million m³/yr.

Also of note is the shift in processing of both spruce/fir and hardwood. In both cases, an increasing proportion of the harvest is first processed in sawmills, with chips being sent on to pulpmills. Today, nearly 80% of spruce and fir harvested is first processed by a sawmill with a significant portion being sent as chips to pulpmills (Fig. 2-4).

In the past year industrial consumption has declined with the closure of several mills, and the future demand for wood supply is unclear. The analysis here thus considers wood supply as a potential that could be available as raw material for a newly emerging mix of industrial enterprises.

Supply from Crown Forest

Approximately 50% of the total New Brunswick wood supply is from the Crown forest. Crown wood supply levels and the management which shapes them are governed by policies established under the Crown Lands and Forests Act.[6] Three aspects of supply are noteworthy.

Fig. 2-3 – Total industrial wood consumption

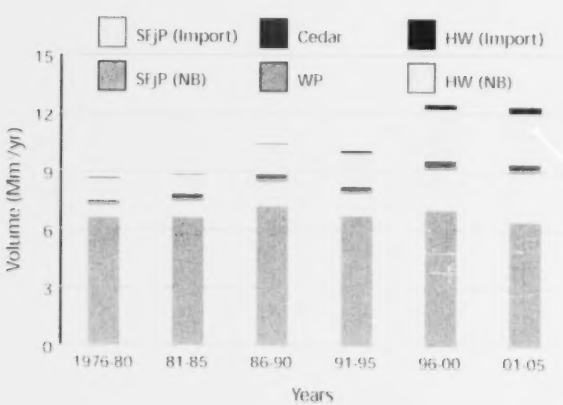
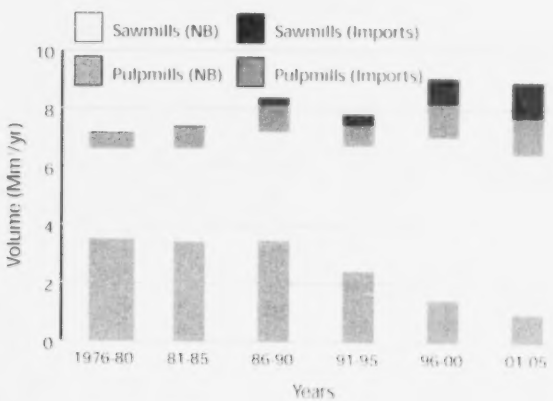


Fig. 2-4 – Spruce/fir industrial roundwood consumption. (Significant chip volume produced from sawmill processing of roundwood is sent to pulpmills).



- Since implementation of the Act in 1982, the annual allowable cut of softwood has declined from a high of 4.2 to a low of 3.3 million m³/yr. This resulted largely from management objectives introduced between 1992 and 2005 to better protect wildlife habitats, water and wetlands, and from establishment of the Protected Areas Network in 1999.

- The investment in silviculture since the 1970s and the resulting higher growth rates will enable an increase in softwood supply in the future. However, in the near-term, and before that increase can occur, the available inventory will reach a critical minimum. This minimum acts like a bottleneck and any decisions that restrict or delay availability of volume during that period will reduce wood supply (Fig. 2-6). Similarly, any decisions that increase or accelerate availability will have a positive supply effect.

- Increasing the spruce/fir wood supply has been the primary focus of management and silviculture investment. Other commercial species have received less management attention, which leaves much uncertainty about the amount and stability of their future supply.

Overall, these consumption trends and supply prospects reveal a number of important issues that warrant attention in addressing Select Committee Recommendation 10 regarding wood supply objectives.

- New Brunswick's current industry is increasingly dependent upon imports, which are a highly unreliable source of supply. Decreasing that dependence, without decreasing consumption, would require an increase in domestic wood supply.

- If the growth in consumption evidenced over the past 30 years is necessary for continued industrial health and survival, then future growth in wood supply will be required.

- While spruce/fir continues to dominate industrial consumption, the overall wood requirements of the industry are increasingly diverse. Today spruce/fir makes up 72% of total industrial consumption in contrast to 83% three decades ago. Diversification of wood supply and its usage offer some hedge against uncertain future forest product markets and is generally consistent with the diverse nature of the Acadian forest.

- Sustainable harvest rates are severely restricted in the short-term by inventory levels (forecast to reach a minimum within 20 years) and there will be unavoidable direct tradeoffs between wood supply and diversity objectives if measures to satisfy the latter restrict or delay volume availability.

- There is a trend towards low grade fibre being viewed as a by-product of processing solid wood, rather than as a primary wood supply objective. This places production priority on wood of a quality suitable for manufacturing of solid wood products, with chips and residue being a supply of raw material for other forms of processing.

The management alternatives set out in Part 5 are designed to address these important aspects of New Brunswick's future wood supply.

Fig. 2-5 – Hardwood industrial wood comsumption

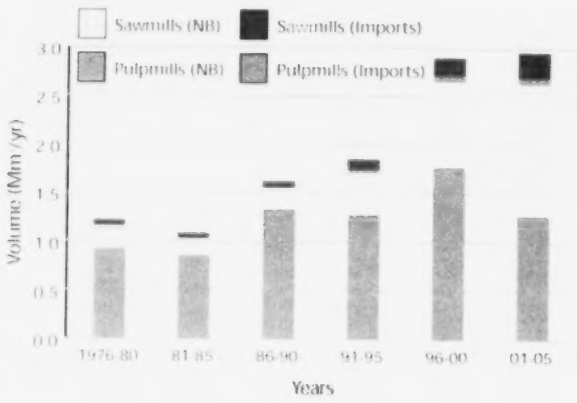
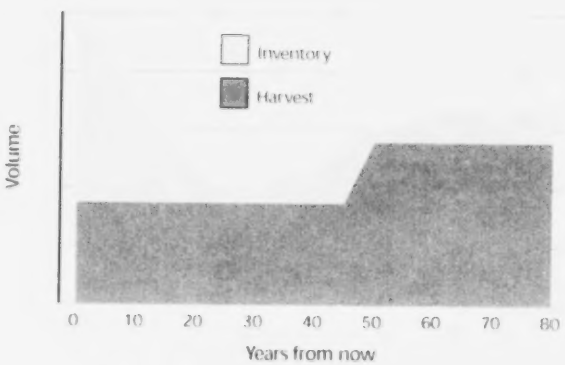


Fig. 2-6 – Conceptual illustration of the short-term inventory limitation on wood supply.



Description of the Public Forest

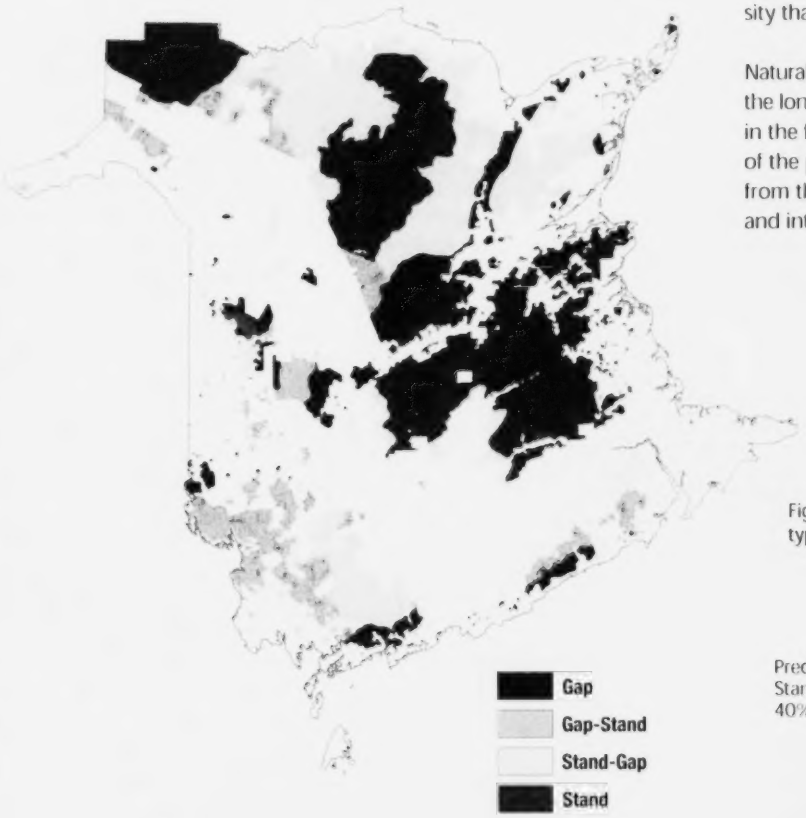
New Brunswick is 85% forested, and of this, 50% (3.4 million ha) is Crown (or public) forest land. The Crown forest is spread across the province, but much of it lies in large, consolidated blocks in the central, northcentral, and northwest regions (Fig. 2-7).

Geophysical and ecological variation across the province results in different forest regions being naturally prone to different types of natural disturbance. According to recent work conducted by the Department of Natural Resources', approximately 40% of the Crown forest, mostly in the east, north-central, and northwest, is naturally and predominantly affected by stand replacing disturbances, caused, for example, by fire and spruce budworm (Fig. 2-8). Eight percent of the Crown forest, mostly in the west-central and extreme south of the province, is naturally and predominantly affected by smaller gap disturbances. Elsewhere, stand and gap type disturbances both operate in significant proportions.

This high degree of variation in disturbance tendency across the province, coupled with the strong ecological connection between type of disturbance and resulting stand type, contribute to the high level of natural diversity that is a distinguishing feature of the Acadian forest.

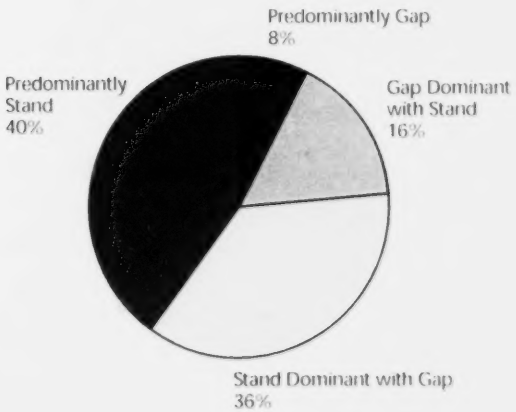
Natural disturbance tendency, geophysical influences, and the long history of human intervention and management in the forest, combine to shape the biological character of the present forest. The forest condition that results from these collective forces has a number of important and interesting features.

Fig. 2-7 – Public forest (green and blue areas combined) subdivided by areas of natural disturbance tendency.



(gap = gap disturbances dominate; stand = stand disturbances dominate; gap-stand = both occur with gap disturbances more prevalent; stand-gap = both occur with stand disturbances more prevalent)

Fig. 2-8 – Crown forest area (%) by natural disturbance type (stand and gap)



Tree Species

At the tree species level, today's forest is dominated by softwood species, which collectively make up 68% of the total standing volume in the forest (Fig. 2-9). Of this total, 36% is spruce (black, white, and red spruce combined) and 19% is balsam fir. Thus, 55% of the inventory in today's forest is spruce and fir. This has changed little over the past 70 years, as previous provincial inventories estimated the spruce/fir content of the forest to be 54% in 1938 and 61% in 1958.

Next in abundance among the softwood species are cedar, jack pine, and white pine, each making up just under 5% of the total volume.

Of the 32% of inventory content which is hardwood, red maple dominates (8%), followed by sugar maple (7%), white birch and poplar (5% each), and yellow birch (4%). Several much rarer species collectively make up 4% of the volume, those being: hemlock, red pine, beech, larch, and in much smaller amounts oak, butternut, ash, and elm.

Late-successional and long-lived species (red spruce, cedar, hemlock, white pine, sugar maple, and yellow birch), seen as distinguishing elements in the Acadian forest, currently make up 33% of the total inventory.

Stand types

These tree species occur in various mixtures on the ground to form stand types (Appendix 3), the abundances of which are strongly influenced by management and disturbance history. The most abundant stand type is spruce/fir, covering just over one-quarter of the land (Fig. 2-10). Roughly a third of this type is in the form of plantations created by the Crown land planting program which began in the 1970s.

Second and third in abundance are the intolerant mixed and balsam fir types, respectively, which together make up 40% of the forest area. Much of the area in these types is in immature stands, largely resulting from clearcut harvesting; and one third of the balsam fir type is a result of softwood-oriented spacing (or pre-commercial thinning).

The tolerant mixedwood, tolerant hardwood, and tolerant softwood stand types collectively make up 25% of the forest and are noteworthy for two reasons. First, they are dominated by the late-successional species that are seen as an important element of the Acadian forest. Second, they are not readily produced by the commonly practised even-aged management regimes that are effective at creating the balsam fir, spruce/fir, and intolerant mixed types. This is evidenced by the absence of late-successional species-dominated stand types in the immature, spaced, and planted landbase (Fig. 2-10).

Fig. 2-9 – Tree species composition (% by volume) of the Crown forest

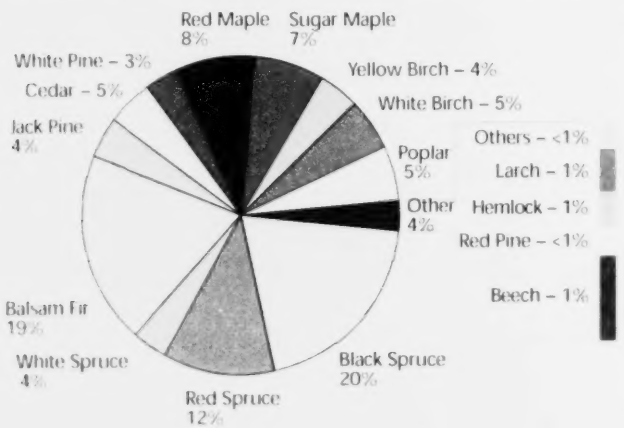
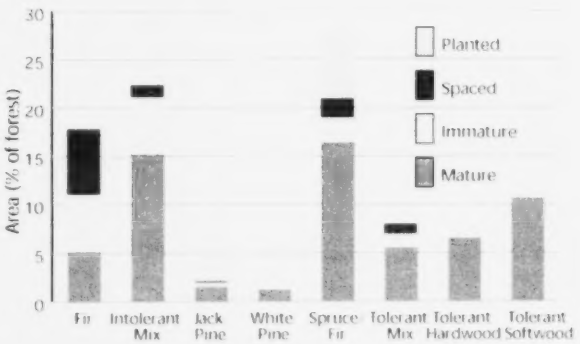


Fig. 2-10 – Stand type abundance (% area)



Forest Age Structure

Forest age class structure is another important forest characteristic, as it reveals the relative abundance of area at various stages of development; and this has important implications for the quantity and quality of wood supply and for provision of habitat types and other forest values through time.

Overall, the preponderance of forest area lies in the 0-20 and 61-80 year old age classes (Fig. 2-11). Forest in the young age classes is primarily a result of recent harvesting and nearly half of this has been planted or spaced.

Less area exists in older age classes (>80 years) because, owing to their higher volumes and larger sized trees, these age classes are targeted by harvesting. The forest that does remain in the older age classes must continue to be the source of wood supply until such time as younger age classes grow into harvestable form.

These old age classes also provide important habitats and play important ecological roles, and thus tradeoffs emerge between objectives of maintaining wood supply and of maintaining old forest on the landscape.

Management Zones

Managing for multiple objectives of this sort has been accomplished under current government policy by the subdivision of the Crown forest into zones, each of which is designed to achieve specific forest objectives (Fig. 2-12).

Protected Areas – Protected areas make up 4% of the forest area. Conservation of natural forest conditions and processes, uninfluenced by human intervention, is the primary objective in these areas, and thus no timber harvesting or management is conducted in them.

Habitat Zones[1] and Buffers – Habitat zones and riparian buffers cover 26% of the forest. The primary objective for them is protection and maintenance of specific forest conditions deemed necessary to:

- support populations of various wildlife species;
- maintain water quality and riparian habitats; and
- maintain plant and animal communities associated with old forest conditions.

Some timber harvesting and management can be carried out in habitat and buffer zones provided they do not compromise attainment of the non-timber objectives for which these zones were created. Protected areas, habitat zones, and buffers are collectively referred to as conservation forest.

General Forest – Objectives in the general forest, which includes 68% of the forest area, are production of timber and protection of normal ecological processes through protection of soil and water, and maintenance or regeneration of forest cover following harvest. The

[1] For simplicity habitat zones and buffers as defined here include the forest vegetation communities, riparian buffers, and old forest habitats that fall outside of protected areas.

general forest is by far the largest source of timber supply, and harvest and silvicultural treatments are designed in accordance with those objectives.

Although not part of the protected or habitat areas, there is an additional 2% of the forest area which is deemed inoperable and unavailable for timber production. Here, the slope is too great, or the ground too wet, or terrain otherwise too difficult to conduct forest operations.

The forest condition differs significantly between these zones, in part because of the nature of management conducted in them as a means to achieve the objectives for them (Appendix 4).

As a result of harvesting, virtually all of the young forest, but disproportionally little of the old forest, occurs in the general forest zone (Fig. 2-13). In contrast, much of the old forest falls in protected areas and habitat zones. This is by design, as conservation objectives require these zones to encompass a preponderance of old forest.

Overall, today's New Brunswick Crown forest is a result of the combined impact of nature and humans. It is a mixed product of the natural processes which have shaped the natural Acadian forest over time, and the many and varied human interventions conducted over several decades as means to both use the forest and to influence its future development.

The present forest presents both opportunity and challenge. The opportunity exists to utilize the forest to generate a diverse and high quality wood supply, supportive of a vibrant forest economy. The challenge is to do so in a way that ensures continual presence of important ecological characteristics of the native Acadian forest.

Fig. 2-11 – Age class distribution (% area)

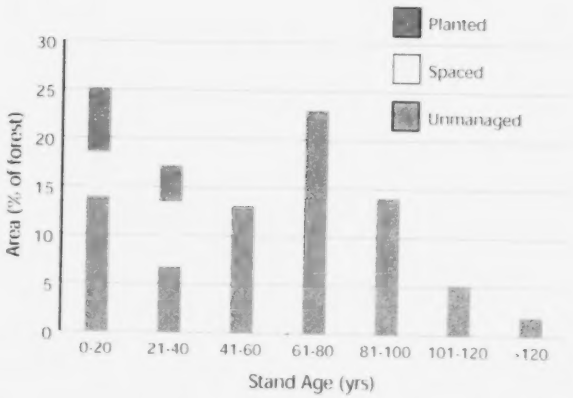


Fig. 2-12 – Area distribution (% area) by management zone

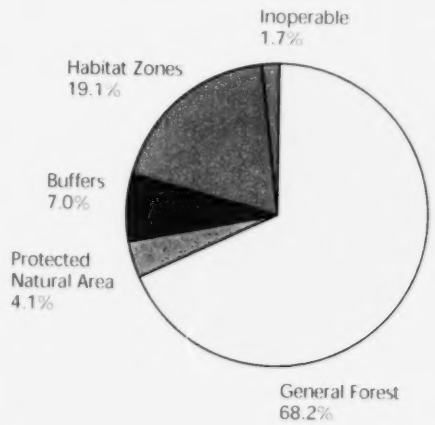
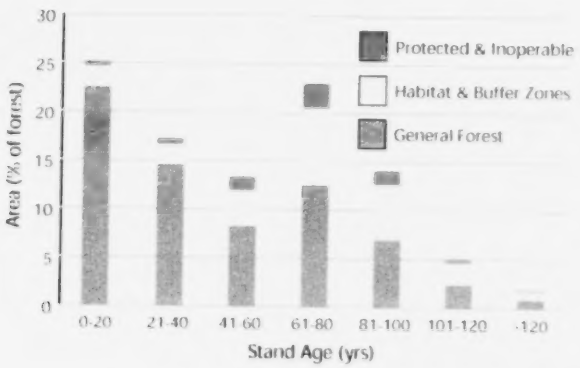


Fig. 2-13 – Age distribution (% area) by special management zone



Part 3
Designing the Management Alternatives

Report of the New Brunswick Task Force
on Forest Diversity and Wood Supply

Assembling information useful for decision-making about forest management alternatives has three fundamental requirements: first is a structured way to define the alternatives; second is a set of measures to express consequences of those alternatives; and third is a means to forecast those likely consequences.

Defining Alternatives

The Select Committee's Recommendations 10 and 11 provide clear general direction about the nature of desirable and appropriate forest management alternatives for the province, but a great many conceivable alternatives conform to the spirit of those recommendations, given their general nature. Such alternatives can vary in a number of ways, including the relative importance placed on wood supply and forest diversity values, the specific objectives sought for those values, and the means by which those objectives are achieved.

Given the many combinations which result from such variation, the Task Force felt it important to design a structured approach to defining management alternatives. The goal was to keep the set small, but broad and varied, so that the alternatives would be both comprehensible and comprehensive in spanning the range of possible ways by which to address the dual objectives of wood supply and protecting the character of the Acadian forest.

The framework used to define the management alternatives was based on seven cornerstone issues. Although there is overlap and interaction between these issues, they stand out clearly as focal points of concern and pose some of the most difficult and contentious forest management questions.

Disagreements about forest management are frequently disagreements about decisions regarding one or more of these issues. Moreover, important on-the-ground impacts are frequently driven by choices made regarding one or more of these issues.

Given their fundamental importance, these seven issues have been used as the common terms by which to define the management alternatives presented in this report. Each cornerstone issue is briefly described below, together with the important questions which accompany it.

Wood supply – What volume of wood can and should be harvested, in what quality and species mix, and at what cost? These characteristics of wood supply directly influence the size, nature, and competitiveness of the forest products sector that can be supported by the forest.

Protected Area – How much area, and in what location and configuration, should be established in zones where no harvesting is allowed? The forest in protected areas develops through time influenced only by natural

dynamics and has important ecological, scientific, and social value, but is unavailable as a source of wood for the forest industry.

Old Forest – How much forest area should be maintained across the landscape in old age conditions? Old forest is produced only by the passage of time and its unique conditions and ecological functions have important ecological and social significance; but it is also an important source of wood supply, frequently containing large trees of high economic value.

Conservation Forest – How much area should be maintained for the primary purpose of protecting riparian environments, wildlife habitats, water resources, and other conservation values? Conservation forest includes the combined area of habitat management zones, riparian and wetland buffers, and protected areas. These are designed for a variety of purposes, among them to support vertebrate populations, provide suitable conditions for other forms of flora and fauna, and to meet water quality objectives. Some of these objectives have recreational and economic implications. Except in protected areas, timber may be harvested, but only in very restricted ways that place primacy on the non-timber value for which the area is managed.

Plantations – How much area should be established in plantations? Plantations are highly productive and efficient sources of wood supply. Establishing plantations is costly and involves practices and creates conditions deemed by some to be ecologically damaging or otherwise undesirable.

Harvest Treatments – What types of harvest and silviculture treatments should be used at what levels and in what stand types? Treatments – like clearcut and selection harvesting, planting, spacing, and commercial thinning – affect forest condition, development, and production. They shape species composition and stand structure; they govern wood supply quantity, quality, and cost; and there exist many diverse views among people about the desirability of their use.

Forest Composition – How much area should be maintained across the landscape in stand types of various species compositions? Stand types (defined by species composition) are the building blocks of the forest landscape and their relative abundance defines the diversity of the forest and the nature of wood supply available from it.

To explore management possibilities, the Task Force has defined a broad set of options for each of these seven cornerstone issues, and combined them in various ways to define unique management alternatives. Forest development under each alternative was then forecast and the resulting outcomes expressed using objective and meaningful indicators.

Indicators of Management Outcomes

Full and fair evaluation of management alternatives requires that likely outcomes be expressed in clear and comprehensive terms, relevant to the many economic, social, and environmental dimensions people associate with forests and the benefits they provide.

Based on workshops held with knowledgeable participants (Appendix 2), the Task Force has defined a set of key measures, or indicators, by which to express management outcomes in terms related to wood-based business opportunity, forest diversity and the environment, and socio-economics. This set includes readily measurable outcomes one would likely consider in evaluating the desirability of any management alternative. Technical definitions and/or source information used for some of the indicators are more fully described in the appendices.

No individual measure on its own provides an adequate basis for evaluating alternatives; and each is imperfect in one or more ways. However, the indicator set was designed to be sufficiently broad and varied that, when viewed collectively, the measures enable an interested party to identify those alternatives they deem most desirable for implementation.

Wood-based Business Opportunity

- Wood supply by species and products
  Wood supply by species and products results from the current forest condition in combination with rates, locations, and prescriptions for harvest and silviculture activities. The physical characteristics of the wood supply determine the nature and variety of possible wood-based business opportunities. Key among these characteristics is the volume of wood available by species and by dimension or product classes. Because of the distinct manufacturing opportunities afforded by different species, wood supply is divided into six major species groups: spruce/fir/jack pine, cedar, white pine, tolerant hardwood, intolerant hardwood, and poplar. To provide some indication of quality, volume in these six groups is broken down by dimension categories, with the larger categories being most suitable for manufacturing solid wood products (Appendix 5). Potential harvest volumes of red pine, larch, hemlock, and beech, all low in abundance, are reported separately.

- Delivered wood cost
  Delivered wood cost is governed by many of the same factors that determine physical wood supply and is the most important economic characteristic of raw material supply. Cost is of fundamental importance in determining the nature and variety of wood-based business opportunities that are economically viable (Appendix 6).

- Wood volume at risk due to spruce budworm
  The New Brunswick forest has for centuries experienced episodic spruce budworm outbreaks and such outbreaks are fully expected to recur. The potential wood volume lost from budworm defoliation is related to the amount and age of susceptible species that exist in the forest. Balsam fir and spruce are the preferred host species of the insect, and suffer significant volume losses during an uncontrolled outbreak (Appendix 7). Spruce and fir are also New Brunswick's most important wood supply species, so this measure of risk is relevant in terms of wood-based business opportunity and to forest protection requirements.

Biological Diversity and Environment

- Forest area by age class
  The age distribution of the forest is governed largely by the rate at which harvesting or natural disturbance

occurs. The faster the rate, the younger the forest. The distribution of forest area by age is an important determinant of wood supply and the availability of various forest conditions over time. Further, since many forest characteristics vary greatly with age, the age structure of the forest is an important indicator of diversity.

- Area of mature and late-successional forest
  The abundance of mature and late-successional forest, collectively referred to here as "old forest", is a function of disturbance history. Old forest has great ecological significance, and typically contains complex canopy structures, large trees (alive and dead), and an abundance of coarse woody debris on the forest floor (Appendix 8). These unique structures provide important habitat for many species of flora and fauna which are not adapted to survive in younger forest, and may provide the regenerative source needed to recolonize maturing forest. Many view such conditions as "old growth", which adds social significance to the existence of mature and late-successional forest.

- Abundance of snags
  Snags are important in providing feeding and nesting sites for certain wildlife species, and eventually fall to the ground where, as coarse woody debris, they continue to provide important habitat conditions and perform important ecological functions. Their presence is influenced by disturbance history in unharvested stands and by decisions made when harvesting and treating stands silviculturally.

- Area of wildlife habitat types
  All forest provides wildlife habitat of some kind. However, managing forests for wood supply can reduce abundance of certain habitat types and such reductions can potentially jeopardize the viability of wildlife populations that depend on them. The New Brunswick Department of Natural Resources has identified habitat types vulnerable to negative management impacts and has set abundance targets for them based on objectives for native vertebrate species populations. The abundance of these habitat types will partially influence the degree to which those population objectives can be realized.

- Area harvested in accordance with natural disturbance tendency
  A prevailing view amongst ecologists is that forest diversity can best be maintained if harvesting is conducted in a fashion that creates or maintains some of the important characteristics produced by the natural disturbances stands commonly experience. Such characteristics would include residual legacy structures in stand-replacing disturbances and tolerant species and multiple canopy layers in gap-replacing disturbances (Appendix 6). The degree to which harvest prescriptions are tailored to reflect natural disturbance influences the degree to which the managed forest resembles the unmanaged one and is, thus, an important indicator of forest diversity and the degree to which distinctive forest characteristics are maintained.

- Area of clearcut harvesting
  Area clearcut as a percent of total area harvested reveals the degree of reliance on clearcutting. Although the indicator "area harvested in accordance with natural disturbance tendency" defined above has more ecological significance, area of clearcut harvesting can have important social significance.

- Area regenerated to non-native species
  Stands of non-native tree species can be created through establishment of plantations. Some non-native species, like Norway spruce, exhibit growth rates superior to native species, and therefore may be desirable as a means of increasing wood supply. However, some people view non-native species as posing an ecological threat, with the potential to become invasive or mix genetically with native species.

- Area of forest by management history
  The collective impact of harvest and silviculture decisions is reflected in the management history of the forest. That history reveals the amount of area treated in fundamentally different ways, each of which, by influencing stand structure and composition, has important implications for both wood supply and forest diversity. Management history is defined here, first, in a three-way distinction between stands which receive no harvest (unmanipulated), those harvested by uneven-aged prescriptions, and those harvested by even-aged prescriptions (Fig. 3-1). Even-aged stands are further distinguished by whether they are planted, spaced, or receive no post-harvest silviculture treatment. Characterizing management history in this way provides an informative overall picture of forest condition, as each of the five resulting conditions is significantly different in terms of stand structure, composition, and productivity.

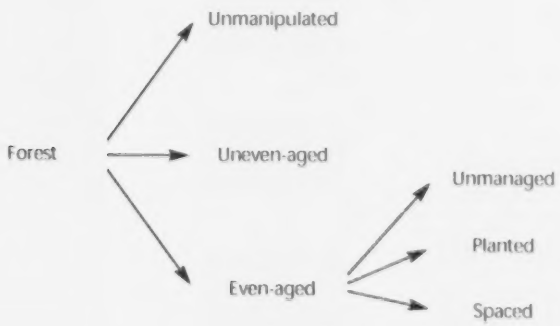
- Area by stand type
  Stand types refer to the mixtures of species growing together in patches or stands on the landscape. They range from single species types to mixes of species in many and varied proportions. Their relative abundance partly defines the overall character and diversity of a forest landscape and is affected by harvest and silviculture practises. Consequently, the area by stand type is an important indicator of forest diversity and management impacts thereon.

- Size and location of protected areas
  The size and location of protected areas result directly from policy decisions about land allocation. Location of protected areas across the province influences what forest and geophysical conditions are protected, and size of individual areas influences the geographic extent over which natural, unmanipulated forest dynamics operate. The general view among conservation biologists is that all stand types and geophysical conditions should be represented in protected areas, and that some protected area should be configured in relatively large contiguous blocks (5000 ha or more). Because no resource extraction occurs in protected areas, forest conditions therein are shaped solely by natural forces of forest dynamics and thus have important ecological and social significance. For the same reason, protected areas have important negative wood supply implications.

- Stored Carbon
  Carbon stored in the forest is a function of the amount of biomass in the forest. Forest management directly affects forest biomass content, and thus affects forest carbon content. Carbon in the forest is carbon that might otherwise enter the atmosphere where it can contribute to the greenhouse effect responsible for climate change. Carbon stocks are therefore an important environmental measure (Appendix 9).

- Buffer width in riparian areas
  The width of forested buffers along watercourses and wetlands is affected by policy decisions that control harvesting in riparian and wetland areas. Riparian buffers are established to protect water quality and, in some cases, riparian habitat and scenic value. Their adequacy in these respects is related to actual buffer widths relative to the minimum required to provide that protection.

Fig. 3-1 – Classification of forest by management history



Socio-economics Related to Wood Supply

- Levels and type of employment opportunities
  Employment opportunities are governed by the amount of harvesting and silviculture undertaken, the quantity and quality of wood supply available for processing, and the nature of processing that takes place. Provision of employment in the woods, processing mills, and related services is a highly important value derived from the forest, but is difficult to forecast given unknown future changes in technology and forest industry structure. Inferences about employment opportunities can also be made with consideration of the wood supply quantity, species, and quality characteristics.

- Royalty revenue
  Royalty, the payment received by the government for Crown wood harvested and consumed by industry, is a function of fair market unit prices for wood by species and quality, and the volume of wood harvested by species and quality (Appendix 10). It represents the direct value received by the government for selling the public timber resource to industry. It does not include tax revenue, another form of income generated by wood processing.

- Value of shipments
  Value of shipments is a function of the volume and value of forest products manufactured and sold. It defines the gross value of forest products and reflects all economic activity directly associated with procuring and processing wood to defined stages of processing (which are pulp, lumber, and veneer in this report).

- Contribution to gross domestic product (GDP)
  Contribution to GDP is a commonly cited economic indicator of resource management strategies. It is driven by the volume of wood harvested, the products into which it is processed, and their value. It defines the overall contribution of the forest products sector to the provincial economy, including all spin-off, and related activities associated with raw material procurement, processing to final product, and marketing.

All of the socio-economic measures cited above are inherently difficult to forecast because of certain, but unknowable, changes in future product values, manufacturing technology, and industry structure. This difficulty has been addressed by presenting socio-economic measures for only the first 10 years of the 100 year forecast horizon, the period during which today's values may be most applicable. Given this short time frame for calculating economic impacts, no discounting was applied.

Inferences about economic opportunities beyond year 10 can be gauged with consideration of the quantity and quality of the wood supplies forecast for each management alternative.

Due to time and resource constraints, it was not possible to undertake the research required to create reliable measures of the socio-economic value of ecosystem services and non-timber forest benefits. Nonetheless, as discussed in Part 7, such benefits warrant consideration in deciding how to manage the forest.

Value Judgements

In addition to the above-listed wood supply, diversity, and socio-economic measures, are numerous non-measurable aspects of management outcomes which are highly important considerations in evaluating the desirability of any management alternative. Many such aspects – for example, those relating to spirituality, aesthetics, and risk perception – are value judgements, requiring personal and subjective interpretation that can vary markedly between people.

These interpretations are undeniably and fundamentally important; all interested parties will undoubtedly make them as part of their evaluation of alternatives. But because of the personal interpretation involved, value judgements are not appropriate for inclusion in this report.

Rather, the intent is that the measurable outcomes which are reported here will allow informed readers to make the personal interpretations of such matters as they deem necessary to evaluate the desirability of the presented alternatives.

Forecasting Management Outcomes

Consideration of future outcomes is essential to evaluating management alternatives, and such consequences can only be gauged by forecasting the impact of each alternative on forest condition and its change over time.

This type of forest development forecasting is a well-established, extensively used procedure which relies heavily on quantitative descriptions of the forest and forest dynamics, and on sophisticated computer models. While the procedure itself is complex, the concept is quite simple (Fig. 3-2). It begins with two ingredients:

- a description of today's forest condition and the dynamics which drive change in the forest, and
- a management alternative of interest, which is defined in terms of objectives sought for the forest and possible actions to be taken.

A computer model is then used to simulate implementation of that management alternative in the forest and to forecast forest conditions that result. Important outcomes of interest (for example measures of wood supply and forest diversity as listed in the previous section) are calculated based on the forecast forest conditions.

A different management alternative can be formulated, and the process repeated, to provide a comparison of outcomes expressed in common measure for the set of alternatives considered. The preferred alternative can be chosen, with full knowledge of how it performs relative to the others whose outcomes are forecast in the same terms.

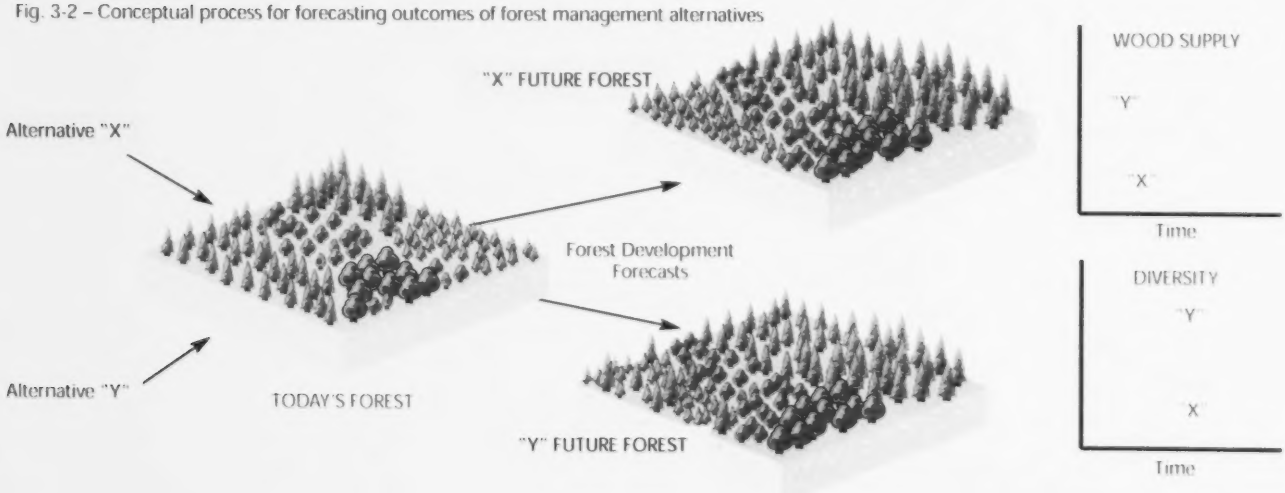
Alternatives presented in this report were examined in this fashion using a 100-year forecast period; and while great pains were taken to assemble the most accurate information possible, the alternatives' outcomes are, unavoidably, based on forecasts. They are thus attendant with a degree of uncertainty and cannot be rendered otherwise.

Forecasts employed to guide forest management might best be viewed in the same fashion one views financial forecasts employed to guide personal retirement planning. Informed users of such forecasts do not take them as flawless predictions of the future, and do not ignore that they are based on inherently uncertain assumptions; but rather glean from them important insight about relative outcomes likely to result from alternate strategies and thereby obtain guidance regarding choice of preferred options.

Implementation of the preferred option is then accompanied by regular monitoring, updating, and correction to account for emerging realities and to ensure desired outcomes are realized.

The forest condition in 2012 was the starting point for 100-year forecasts for all management alternatives. This is the date at which new management plans will be developed for Crown land and is the point at which new management objectives can be introduced. Approved management plans for the period 2007-2012 were applied to the current forest inventory to create the 2012 forest condition.

Fig. 3-2 – Conceptual process for forecasting outcomes of forest management alternatives



Part 4
Management Issues, Options and Impacts

Report of the New Brunswick Task Force
on Forest Diversity and Wood Supply

Defining forest management alternatives in terms of the seven cornerstone issues discussed in Part 3 involves selecting from amongst the various possible options for each. This raises the questions "what are those options?" and "what effects do they have?".

Presented here for each cornerstone issue is a set of options deemed by the Task Force to be generally consistent with the spirit of Select Committee Recommendations 10 and 11.

But even within the bounds of these recommendations, no single option for any issue is "correct" or "best"; that verdict will vary between parties with dissimilar interests and perspectives. Accordingly, the options were designed to vary in the relative degree to which they address wood supply and diversity objectives to encompass a broad range of possibilities.

As requested by the Department of Natural Resources, this set of options includes ones which conform to the recommendations on forestry made in the report of the New Brunswick Self-Sufficiency Task Force.[1] Also presented for all seven issues are the status quo options, ones that reflect elements of the forest management strategy for Crown land as currently implemented.[2]

In this section, each of the seven cornerstone issues is addressed in turn. The options for each are first explained and justified in the context of the Task Force's mandate. Then, forecast outcomes that result under the various options are quantitatively presented and briefly discussed.

This one-by-one approach to the cornerstone issues and associated options is useful to isolate and reveal the cause-effect relationships between selected options and the nature and degree of their impacts on the forest and what it can provide. It is intended to establish a basis from which to understand and interpret the management alternatives presented in Part 5. Each alternative presented there is composed of various combinations of options for the seven cornerstone issues.

It is especially important to note that information in this section can be used to infer outcomes for management alternatives readers might formulate which differ in some respect from those presented in Part 5.

Wood Supply

Description

The Select Committee Recommendations regarding wood supply focus on "...increasing yields of a wider variety of commercial tree species ..." and "...creating greater future diversity and opportunity" in the forest industry.[1] In keeping with this focus, the wood supply options were formulated in terms of:

- dimension classes based on tree size (volumes in the largest dimension classes are collectively referred to as "log-potential" - defined in Appendix 5);
- six species groups[1], namely spruce/fir/jack pine (referred to as spruce/fir), white pine, eastern cedar, tolerant hardwood (sugar maple, yellow birch), intolerant hardwood (red maple, white birch), and poplar; and
- timing preference.

All options except the status quo include the requirement for a non-declining harvest of total and log-potential volume in each of these six species groups. A non-declining supply allows harvest volumes to remain constant or increase over time, but not decrease. The prevention of a declining harvest volume was deemed consistent with the Select Committee Recommendations and with the general concept of long-term sustainability.

The wood supply options are differentiated on the basis of species groups given priority for production. Priority is assigned using differential species weightings that control harvest and silviculture treatments which favour production of some species over others.

Given their naturally limited abundance in the Acadian forest, intolerant hardwood and poplar were not given priority under any option. However, they were assigned a non-declining wood supply objective under all options except the status quo.

Although the objective is to maximize and sustain wood supply over the entire planning horizon, preference for early rather than later supply is exercised using a 4% discount rate in all but the status quo options (which uses an 8% rate). This recognizes the importance of supplying existing mills, but does not unduly sacrifice long-term wood supply to meet short-term interests. Effects of changing this timing preference are examined in a sensitivity analysis presented in Part 6.

Options

- Status Quo – The wood supply objective has a first priority to maximize the total spruce/fir supply in the short-term. Next, in decreasing order of priority, are objectives to maximize long-term spruce/fir supply, maximize short-term hardwood supply, and maximize long-term hardwood supply. Objectives are set only in terms of total volume, with no explicit consideration of product or log-potential. There are no specific controls over cedar, white pine, or individual species within the overall hardwood category.

- Spruce/fir Priority – The objective is to maximize the combined wood supply of log-potential spruce/fir, cedar, white pine, and tolerant hardwood over the entire 100-year planning horizon. Spruce/fir production is favoured over other species by being preferentially weighted.

- Non-Spruce/fir Priority – This is identical to the above option except that species priorities are reversed. White pine, cedar, and tolerant hardwood are preferentially weighted over spruce/fir.

- Equal Priority – This option is the same as the two above, except spruce/fir, cedar, white pine, and tolerant hardwoods all have equal weighting.

1 Because of their low abundance, hemlock, larch, red pine, and beech wood supply levels are reported separately in Part 5.

Impacts

These four wood supply options affect log-potential production of all species groups in both the short-term (years 1-25) and long-term (years 26-100).

- Any move away from the status quo reduces spruce/fir harvest in the short-term (Fig. 4-1). Under the status quo, stands of mixed composition are harvested to increase spruce/fir volume in the short-term, but this generates a variable and unsustainable fallout of other species.

  The other three options have a common objective to sustain the log-potential supply of white pine, cedar, and tolerant and intolerant hardwood, and poplar. Sustaining these species requires lowering the harvest rate of mixed stands, thereby reducing spruce/fir supply in the short-term. This restriction results in a 4% reduction from the status quo under the "spruce/fir priority" (Fig 4-1).

- The short and long-term spruce/fir supplies are lowest under the "non-spruce/fir priority" option, as harvest and silviculture treatments are oriented towards maximizing production of other species. The benefit of such treatments surfaces in a slightly increased short-term combined supply of white pine, cedar, and hardwood, and a substantially increased long-term supply of those species (Fig. 4-2). But, relative to the "spruce/fir priority", these absolute gains (0.5 vs 0.4 million m³/yr – Fig 4-2) are much lower than the spruce/fir reductions which accompany them (2.4 vs 2.1 million m³/yr – Fig 4-1).

- The "equal priority" option combines targeted species production in relatively pure stands, and species co-production in mixed stands to generate a wood supply with a species mix that falls between those resulting from the "spruce/fir" and "non-spruce/fir" priority options.

  "Equal priority" achieves 99% of the short and long-term spruce/fir supply available under the "spruce/fir priority" option, and 86% and 72%, respectively, of the short and long-term supply of cedar, white pine, and tolerant hardwood combined supply available under the "non-spruce/fir priority". But under the "equal priority" priority option the absolute supply increase of non-spruce/fir species is less than the accompanying supply decrease of spruce/fir.

Fig. 4-1 – Spruce/fir (SF) log-potential wood supply in the short and long terms

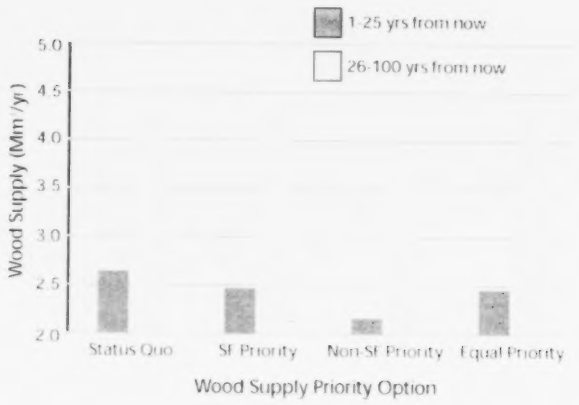
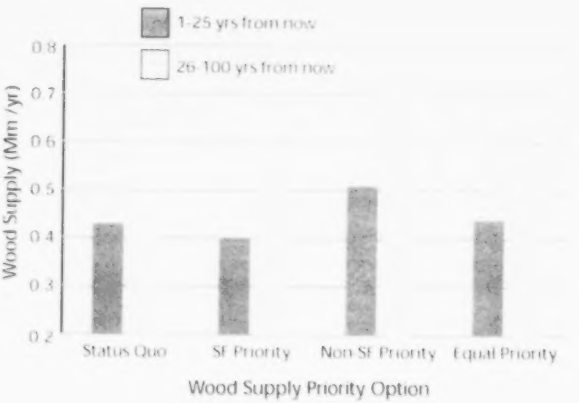


Fig. 4-2 – White Pine + Cedar + Tolerant HW log-potential wood supply in the short and long-terms



Protected Areas

Description

Protected areas are those in which no timber extraction or forest management activities are allowed. Increasing protected area is a means to retain more unmanaged forest on the landscape, thereby increasing the area of stand types shaped by natural forces.

Options for increasing protected area were defined in terms of:

- percent forest in protected areas;
- percent area added from existing habitat zones; and
- spatial configuration in large or small blocks (Table 4-1).

All options were derived from a network of protected areas proposed by the World Wildlife Fund-Canada (WWF-Canada) to provide "full forest representation".[1] The WWF-Canada network areas coincide with priority areas identified by the Nature Conservancy of Canada[2], The Nature Conservancy (US)[3], and in the Lapierre et al. study.[4] As such, they represent a logical basis from which to derive protected area expansion options.

Creating protected areas in existing habitat zones mitigates wood supply impact because timber extraction is already restricted therein, but such areas may be too small to meet protected area objectives requiring large spatial extents. These relatively small habitat patches would serve a site-specific role of maintaining important forest conditions distributed across the landscape.

Options

- Status Quo – This includes the current protected areas, which cover 4% of the forested Crown land.

- 10% – This option conforms to recommendations of the Self-sufficiency Task Force.[5] The area added to the protected network is configured in small blocks and comes entirely from current habitat zones that fall within the WWF-Canada proposed areas. Consequently, this option does not reduce the general forest area and has minimal wood supply impact.

- 13% – This option increases the protected area three-fold from the status quo to 13% of the Crown forest. Two-thirds of this increase is in large blocks, mostly greater than 4000 ha, chosen for maximum overlap with current habitat zones and to provide roughly equal representation across ecological zones in the province. The remaining one-third is small blocks drawn entirely from habitat zones falling within WWF-Canada proposed areas.

- 16% – This option includes 75% of the WWF-Canada "full representation" network. The additional area is in large blocks, drawn evenly from general forest and habitat zones.

- 22% – This option includes the entire WWF-Canada "full representation" network. The additional area is in large blocks, drawn almost evenly from general forest and habitat zones.

Table 4-1 – Protected area option summary

Option	% of forest	% area added from		% area added in	
		habitat zones	general forest	large blocks	small blocks
Status Quo	4	n.a.	n.a.	n.a.	n.a.
10%	10	100	0	0	100
13%	13	67	33	67	33
16%	16	50	50	100	0
22%	22	45	55	100	0

Impacts

Protected area options have a significant impact on the proportion of the forest unmanipulated for timber production, the amount of old forest conditions, and the available wood supply.

- No management occurs in protected areas, so unmanipulated forest area increases directly with amount of protected areas, ranging (at forecast year 50) from 23 to 31% of the forest area across the options (Fig. 4-3).

- Much of this unmanipulated forest retains or develops old forest characteristics as more stands develop to advanced age in the absence of timber harvesting under the increased protected area options (Fig. 4-4).

- Wood supply of all species decreases with increasing area in protected areas because the conservation objectives for such areas preclude timber production (Fig. 4-5). Although adding 6% of the total forest to protected areas, the "10%" option has only a 2% short-term wood supply reduction as all the additional area is drawn from habitat zones, where timber availability is already reduced. The impact increases to 7% under the "13%" option, because the large block configuration can only be formed by drawing general forest into the protected landbase (Table 4-1). This reveals a trade-off between wood supply and both the extent and configuration of individual protected areas.

- The wood supply impacts of protected areas are not as great in the long-term (Fig. 4-5), after the near-term inventory constraint has passed (Fig. 2-6).

Fig. 4-3 – Unmanipulated forest area (%) at forecast year 50

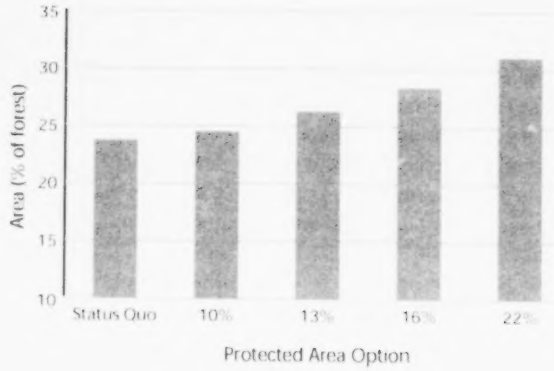


Fig. 4-4 – Area (%) in old forest condition at forecast year 50

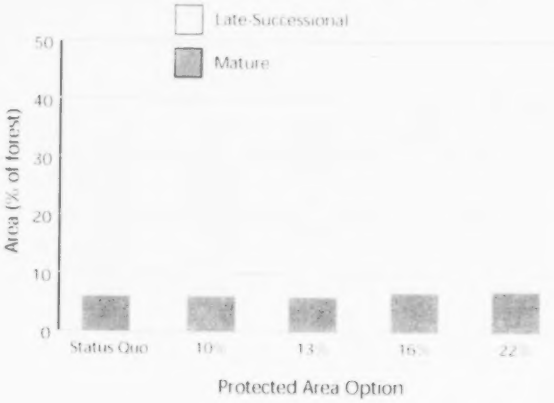
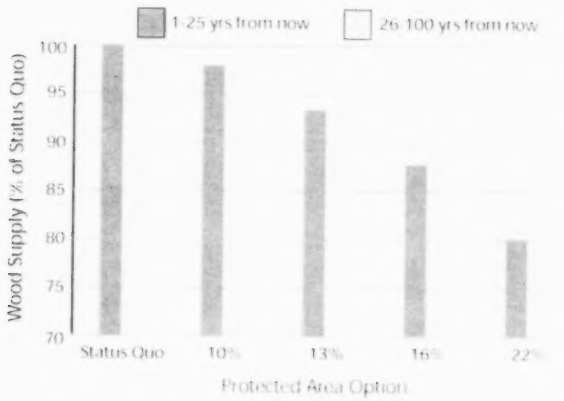


Fig. 4-5 – Log-potential wood supply of all species in short and long-term as % of status quo



Conservation Forest

Description

Conservation forest is that in which the primary objectives are to conserve and protect a variety of non-timber forest values. It comprises habitat management zones, riparian and wetland buffer zones, and protected areas, with respective objectives to conserve specific wildlife habitats, protect water quality and riparian environments, and conserve representative portions of the forest whose development is shaped only by natural environmental forces.

Timber extraction may occur in habitat and buffer zones, but only if it can be conducted without compromising the non-timber objectives for which the zones were established. The harvest rate per unit area in habitat zones is 25% (or less) of that in the general forest.

On one hand, conservation zones maintain important ecological features of the Acadian forest; on the other they restrict wood supply. Options defined for the conservation forest include both increasing and decreasing its area relative to the status quo (Fig. 4-6). Reducing conservation forest area is one means to increase wood supply. Increasing it is one means to increase the abundance of habitats and forest conditions that do not typically exist where timber management is practised. Under all four conservation forest options described below, protected area is kept at its current level of 4% of total forest area.

Options

- Status Quo – The total area in conservation forest is approximately 30%; 4% is in protected areas and 26% is in habitat and buffer zones outside of protected areas. The habitat zones include deer wintering areas, old forest habitats, and old vegetation communities.[17]

- 25% – Area in conservation forest is set at 25% of the total forest. The general forest zone is increased from 70% to 75% by removing from the conservation forest unoccupied deer wintering areas, young forest in old forest habitat blocks, and riparian buffers which exceed documented DNR requirements.

- 20% – This option was recommended in the Self-Sufficiency Task Force report.[11] It reduces the conservation forest area to 20% and increases the general forest to approximately 80% of the total area. In addition to the conservation forest reductions of the "25%" option, area is proportionally reassigned from habitat zones to general forest as needed to reduce conservation forest area to 20%.

- 37% – This option increases the conservation forest to 37% and reduces general forest to 63%. The increase to 37% was achieved by reclassifying as conservation forest some of the general forest located in priority areas defined in the protected area network proposed by WWF-Canada.[18]

Impacts

Impacts of the conservation forest options are most pronounced in terms of wood supply and abundance of mature forest wildlife habitats.

- The wood supply of all species changes in inverse proportion to the area in conservation forest (Fig. 4-7) because timber management activities are restricted therein. The current age structure of the forest poses a timber inventory shortage in the near-term that makes the impact of conservation options more pronounced in the short-term than in the long-term.

- Reducing the conservation area under the "20%" option produces nearly a 20% gain in short-term wood supply (Fig.4-7), which is the primary reason for its inclusion in the forestry recommendations presented in the Self-Sufficiency Task Force report. The volume made available by reducing conservation forest relaxes the near-term inventory constraint, thus allowing wood supply to increase significantly.

- A primary objective of the conservation areas is to provide habitat to maintain wildlife populations at desired levels. Reducing the conservation area opens stands up to management practises that, while good for timber production, change the structure of stands, rendering them less suitable to provide specific wildlife habitat.

- Under the "20%" conservation area option, old forest habitats at year 50 drop to 80% of what they would be under the status quo; and they would continue to drop thereafter (Fig. 4-8). Increasing the conservation area has the opposite effect, as stands left unharvested maintain or grow into old forest habitat conditions.

- The "25%" option includes harvesting in currently unoccupied deer wintering areas, resulting in reduced future habitat abundance, and potentially, lower future deer populations relative to what might exist were such areas not harvested.

- The specific impacts of the "20%" option will depend upon the type and location of forest removed from the conservation zone. However, since the option results in reduced abundance of some habitat types, it follows that reduced populations of dependent species will also result, perhaps falling below current objective levels.

Fig. 4-6 – Area (%) by management zone for conservation forest options

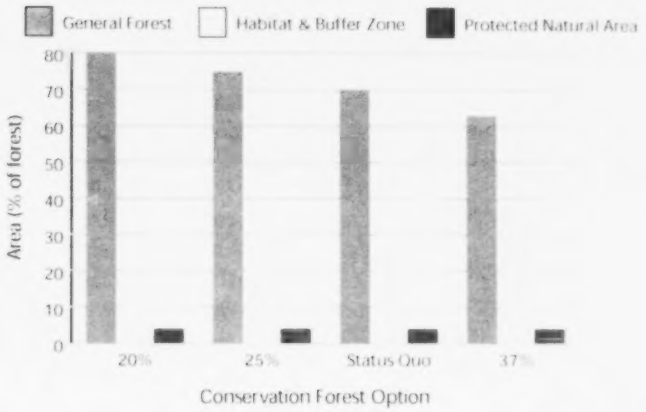


Fig. 4-7 – Log-potential wood supply of all species in short and long term as % of status quo

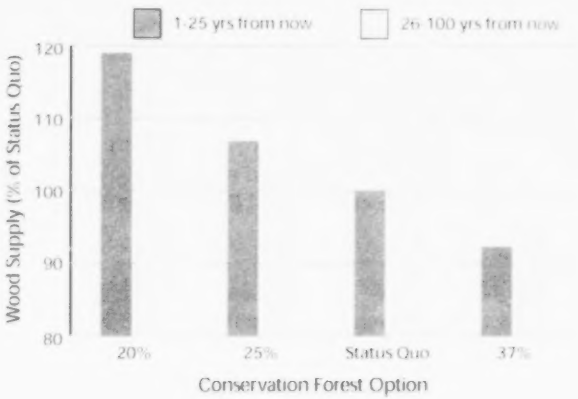
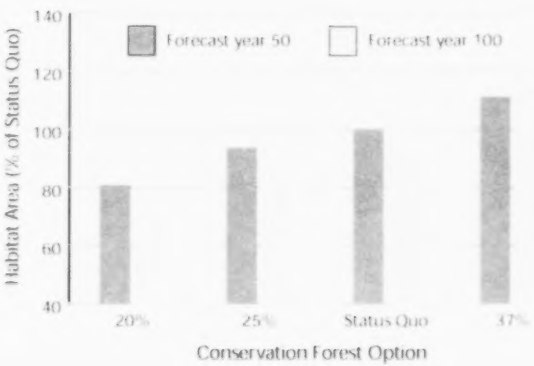


Fig. 4-8 – Total old forest habitat at forecast years 50 and 100 as % of status quo



Old Forest

Description

Old forest is defined in terms of stand structural attributes which develop as stands reach advanced age and which provide unique and necessary conditions for the growth, survival, and reproduction of various plant and animal species.

It differs from the old forest habitats just discussed, in that old forest habitat is defined in terms of requirements for specific vertebrate species. Old forest as discussed here plays a more general role: it provides conditions deemed necessary to maintain biological diversity across all fauna and flora (e.g. lichens, fungi, bryophytes) that reside in or depend on conditions found only in old forest.

Two old forest conditions have been defined, namely mature and late-successional forest, each being based on stand structural attributes (Appendix 8). Late-successional forest is an older condition into which mature forest develops, and constitutes what some consider to be "old growth". It represents the most physiologically advanced state to which stands develop and is therefore an important contributor to forest diversity.

The old forest options are defined and vary by the minimum percentage of each stand type to be maintained on the landscape in both mature and late-successional forest condition.

Abundance targets in each option are set on a stand type basis because the character of old forest differs with stand composition, as does the time required for old forest conditions to develop. For example, they develop more quickly in balsam fir and poplar types than in cedar or tolerant hardwood types.

Options

- Status Quo – The status quo does not define old forest in the sense used in this report, so it contains no directly relevant objective. Its closest elements are the old forest habitats and vegetation communities, each of which has objective levels set under current management standards.[1] Although no specific objectives are set for mature and late-successional forest as defined here, their combined abundance remains at or above 25% of the total forest area as an indirect consequence of meeting habitat and vegetation community objectives.

- 25/8 – In this option old forest area targets are set by each of eight broad stand types (Appendix 3). For each, mature forest is maintained above 25% and late-successional forest above 8% of the area in the type. These levels approximate what results indirectly under the status quo, but are a more explicit and direct statement of old forest objectives.

- 40/12 – In this option mature forest and late-successional forest area targets are increased to 40% and 12%, respectively, on a stand type basis. These percentages are within the range of levels recommended by the Greater Fundy Ecosystem Research Group in its guidelines for maintenance of biological diversity.[2]

Impacts

The old forest options have greatest impact on wood supply and abundance of old forest conditions.

- The "25/8" option has virtually no effect on wood supply relative to the status quo. There are no objectives in the status quo that fully conform to the old forest objectives applied here, which include individual "25/8" targets for each stand type; however, old forest outcomes similar to those of the "25/8" option are realized as an indirect result of other objectives in the status quo, particularly those for old forest habitat and vegetation communities (Fig. 4-9).

- Maintaining more old forest as required under the "40/12" option decreases the short-term log-potential wood supply of all species by 11% relative to the status quo (Fig. 4-9). This occurs because reducing the rate of harvest is necessary to create higher levels of old forest.

- The negative wood supply effect of the "40/12" option disappears in the long-term, as the reduced harvest early on allows stands to attain older ages and higher volumes when they are eventually harvested.

- Although there is a 15% difference in old forest targets between the "25/8" and "40/12" options, there is only a 5% difference (35% vs 40%) in total old forest area that results under them (Fig. 4-10). Forest conditions brought about by other management objectives in the scenarios result in more old forest for some stand types than is required by the minimum targets set under the old forest options.

Fig. 4-9 – Log-potential wood supply of all species in short and long term as % of status quo

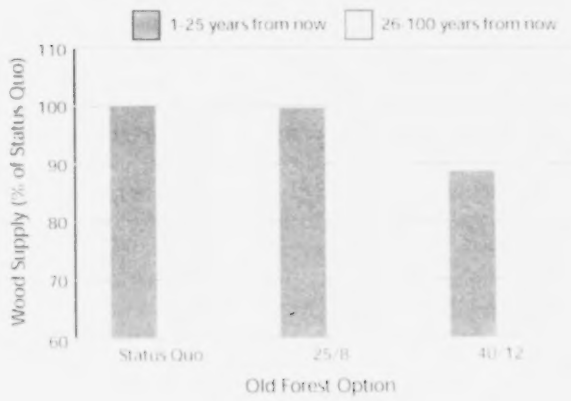
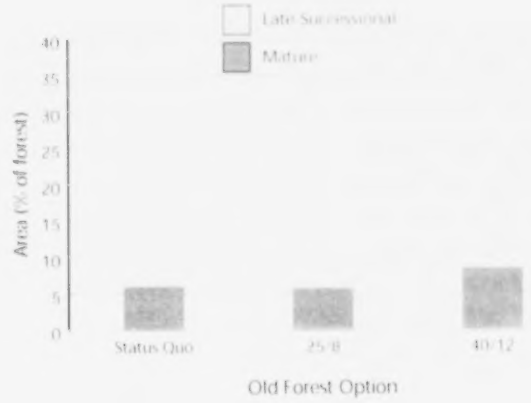


Fig. 4-10 – Area (%) in old forest at forecast year 50



Plantations

Description

The proportion of the forest under intensive management for timber production is of concern from wood supply, environmental, and social perspectives. Plantations, the primary form of intensive management, can have powerful influence over both wood supply and forest diversity.

Options were defined in terms of percent of forest area in plantations and range from low values, in recognition that some view plantations as compromising the Acadian forest character, to high values, in recognition of their significant contribution to wood supply.

Spacing (also referred to as pre-commercial thinning) is sometimes viewed as an intensive treatment, but is not considered so here for three reasons.

- Spacing does not involve some intensive practices used in plantations which prompt environmental and social concerns; there is no site disturbance through site preparation and no use of herbicides.
- Spacings tend to have higher species diversity than plantations and provide a significant opportunity to control species composition and to increase the content of late-successional tree species.
- Spacing may be a key treatment in some uneven-aged silviculture prescriptions to further promote the presence of late-successional species in maintenance and restoration treatments. Its use can thus have a positive influence on forest diversity.

In all options, plantations are of softwood species, with species being mixed in various proportions at the site level (e.g. 10% white pine planted with white spruce), as is often the current practise.

Options

- Status Quo – There is no direct control over the amount of the total landbase which may be planted. Plantation area is simply a consequence of the silviculture budget and the other objectives which are part of the management strategy. The plantation area increases over the next 50 years to approximately 25% of the total forest.
- 0% – Under this option, planting is discontinued from 2012 forward. As existing plantations mature, they are harvested and then left to regenerate naturally, causing the plantation area to approach 0% of the forest area over time.
- 13% – This option limits plantation area to 13% of the forest, roughly what it will be at the end of the current planning period in 2012. Harvested plantations can be replanted, but the net plantation area does not increase above 13%.
- 19% – This option limits plantation area to 19%, which is half-way between the 25% to which plantation area will rise under the status quo and its 2012 state of 13%.
- 25% – Under this option, plantation area can increase to 25% of the forest area. This is the plantation area that will eventually result with continuation of the current silviculture program. It is differentiated here from the status quo as an explicit area level, not as an indirect fallout of the silviculture budget.
- 37% – This option allows plantation area to increase roughly threefold from its 2012 area. It is consistent with the recommendation in the Self-Sufficiency report.

Impacts

The impacts of plantation area options are manifest primarily in terms of spruce/fir wood supply, extent of plantations on the ground, and forest composition.

- Because of the time required for plantations to become harvestable, the short-term wood supply is insensitive to the amount of area planted (Fig. 4-11). However, the high yields in plantations significantly increase spruce/fir wood supply in the medium and long-terms; and the effect is in direct proportion to the amount of area planted. Available wood supply increases 60% in the long-term under the "19%" option and more than doubles under the "37%" option.

- Plantation area changes through time as one would expect, increasing to 37% of the forest area for the highest plantation option and falling to 0% under the lowest (Fig. 4-12).

- Planting affects forest composition primarily by shifting area from a fir-dominated softwood type, which results from natural regeneration following clearcutting, to a spruce-dominated softwood type, which results from planting spruce seedlings (Fig. 4-13). Additionally, the area of pine and tolerant softwood types increases with area planted, because the species which form these types (primarily white pine and red spruce) are among the species planted. Planting has minimal effect on abundance of other stand types because the non-declining harvest flow constraints for hardwoods and cedar prevent major conversion to plantation of stand types dominated by these species.

Fig. 4-11 – Spruce/fir log-potential wood supply in the short, medium, and long terms

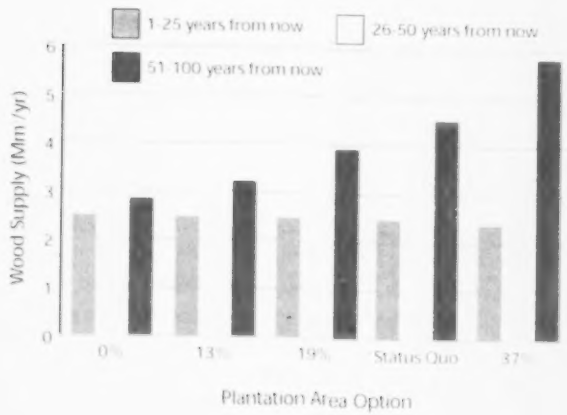


Fig. 4-12 – Area (% of total forest) in plantations over time

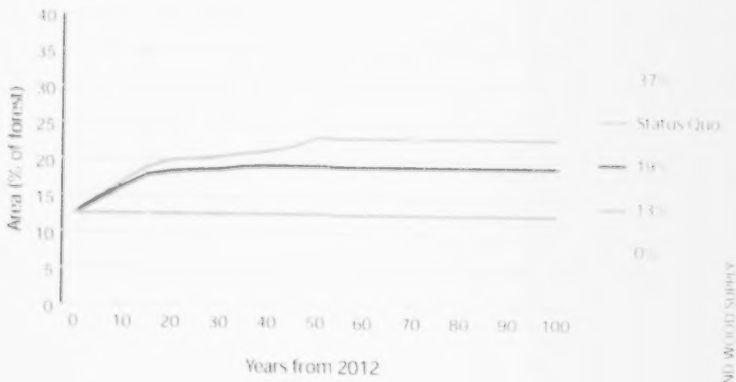
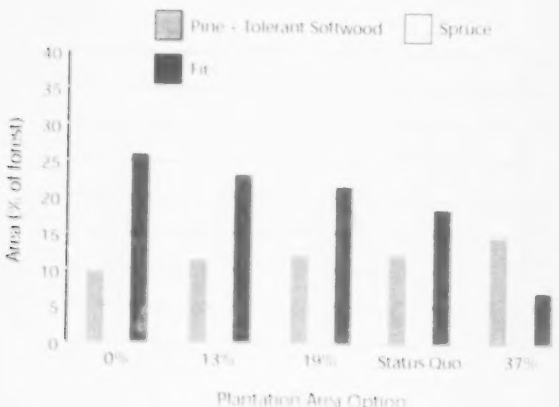


Fig. 4-13 – Area (%) of softwood stand types at forecast year 50



Harvest Treatments

Descriptions

Harvest treatments (or prescriptions) are implemented in the forest as the means to extract timber, control species composition, and influence stand structure. They are all-important in influencing the composition and quality of wood supply, and the compositional and structural characteristics of the forest.

The treatment options were defined in terms of what harvest treatments are to be conducted in what stand types (Appendices 6 and 13). Harvest treatments, in turn, are defined by how much and what components of the stand overstory remain after each harvest entry, and by the timing between successive harvest entries.

Clearcut harvesting leaves no overstory, tends to disfavour late-successional species, results in even-aged stands, and can lead to increased composition of balsam fir and intolerant hardwoods. It is the most cost efficient harvest type and is the best means to create areas for planting.

Shelterwood and selection harvesting, properly implemented, leave portions of the overstory intact and can favour late-successional species, which tend to be shade tolerant. Coupled with appropriate timing between harvest entries and retention levels, these non-clearcut treatments can both favour late-successional species and create uneven-aged or complex stand structures, two important ecological features of the Acadian forest.

Defining each treatment option in terms of what stand types are eligible for what harvest treatments was based on consideration of the current late-successional species content in stands. These species include red spruce, white pine, cedar, hemlock, sugar maple, yellow birch, and in some cases, red maple. With the exception of the last two, these species tend to be disfavoured by clearcutting.

Options

- Status Quo – This is the current policy that prevents clearcut harvesting of stands where tolerant hardwood, red spruce, cedar and white pine individually exceed half of the stand volume. It does not include permanent retention in harvested areas.

- Maintain Late-successional Species – In this option all stands with a combined presence of late-successional species exceeding 50% of stand volume must be harvested by appropriate non-clearcut treatments. The goal is to maintain these stands as dominated by late-successional species, and to maintain or create the multi-aged conditions in which they typically grow. To provide within-stand structural diversity, 5% permanent retention is maintained in all harvest areas.

- Restore Late-successional Species – This option requires non-clearcut treatments in all stands in which the combined presence of late-successional species exceeds 20% of stand volume. This lower threshold requires non-clearcut harvesting in stands whose late-successional species content has likely been reduced by past management. In these cases, the treatment is restorative in the sense that non-clearcut harvesting is designed to foster an increase in the content of late-successional species. Like the previous option, 5% permanent retention is maintained in all harvest areas.

- Natural Disturbance – This option adds to the "restore late-successional species" option by increasing permanent retention areas within harvested stands, thus creating within-stand structural variation similar to that resulting following natural disturbance events. Retention levels are set at between 10% and 20% in all harvested stands, and this amount of area is left to develop naturally and provide more large live and dead trees, coarse woody debris, and other ecological legacy features at the stand scale over time.

Impacts

The treatment options significantly impact species composition and stand structure, and wood supply volume and cost.

- The future standing inventory of late-successional species clearly responds to treatment options, increasing eventually by 19% to 29% over the status quo, depending on the treatment option (Fig. 4-14).

- Further, the area of uneven-aged stands (created by non-clearcut harvesting), of where late-successional species predominate, increases, from 10% under the status quo to 18% under the "restore" and "natural disturbance" options (Fig. 4-15).

- Non-clearcut harvesting delays harvest of merchantable trees left standing between harvest entries. This has no significant wood supply effects in the long-term; but it does in the short-term if this delay occurs when inventory levels are at their minimum (Fig. 4-16). Also, the "maintain" and "restore" options leave 5% of each stand permanently unharvested for continuous provision of within-stand structural features, including large live trees, large snags, and coarse woody debris. These two factors result in short-term wood supply reductions to 93% and 89% of the status quo level as the "maintain" and "restore" options are introduced, respectively. Without 5% permanent retention, the wood supply for both options would increase by 5%, equaling 98% and 94% of the status quo supply. Wood supply drops further to 84% with the "natural disturbance" option which leaves 10-20% of each stand permanently unharvested to provide long-term structural diversity.

- Because clearcut harvesting is less costly, on average, than other harvest treatments, the delivered wood cost increases directly with the amount of volume harvested by non-clearcutting treatments. In the most extreme case, it rises to 8% above the status quo cost (Fig. 4-16).

Fig. 4-14 – Standing volume of late-successional species at year 100 as % of status quo

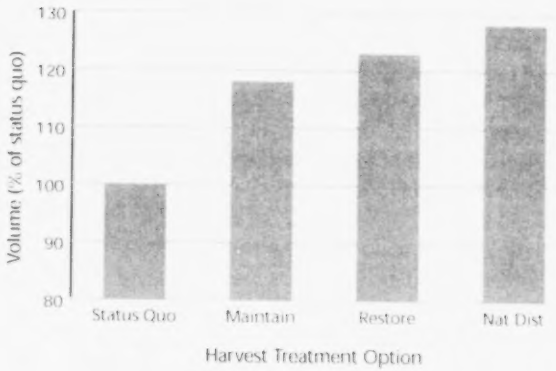


Fig. 4-15 – Area (%) by management history at forecast year 100

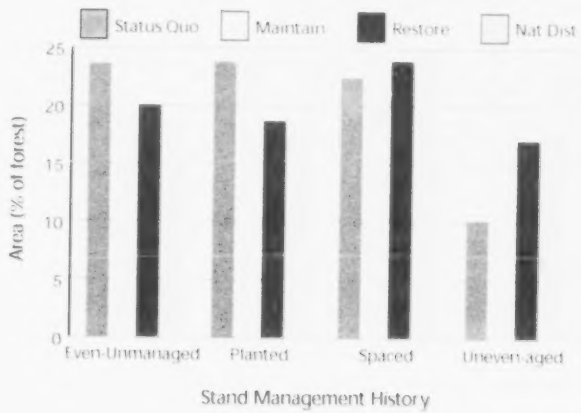
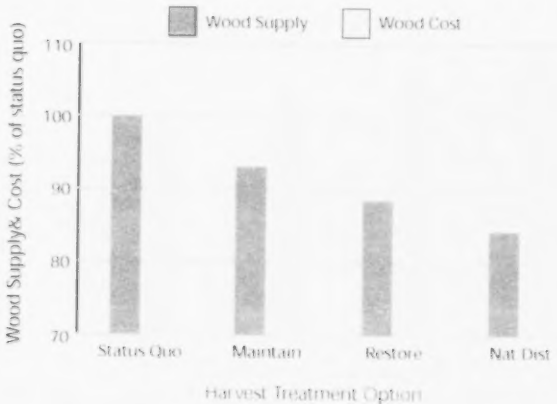


Fig. 4-16 – Log-potential harvest and delivered wood cost relative to status quo (forecast years 1-25)



Forest Composition

Description

Forest composition refers to the relative abundance of stand types, where such types are defined by certain mixtures of species in specified relative amounts (Appendix 3). It is one of the important ecological features of the Acadian forest, and a fundamental determinant of forest diversity.

Forest composition options were stated in terms of the relative abundance of stand types on the landscape and referenced to the pre-1940 forest condition. Pre-1940 was chosen as an appropriate benchmark period because it predates widespread use of industrial forestry practises common today.

Using methods similar to those developed by Zelazny et al.[1], the pre-1940 forest composition was approximated and percent area by stand type compared to that of today (Appendix 11). Six stand types appear to be less abundant on the landscape today than before the modern era of forestry practise, those being:

- eastern hemlock
- eastern cedar
- white pine
- red spruce
- tolerant hardwood
- tolerant mixedwood

These findings are consistent with those reported from other studies of historical composition of the Acadian forest.[2]

In the composition options, abundance targets were set for these "under-represented" types, relative to the pre-1940 condition and in consideration of what stand types may be best adapted to future climatic conditions expected to occur as a result of climate change (Appendix 12).

An oft-cited concern about the Acadian forest is an increase of intolerant tree species above natural levels as a result of human intervention. In recognition of this, all options except the status quo cap the intolerant hardwood stand type at 20% of the forest area. This percentage was based on the approximation of the pre-1940 forest composition.

Options

- Status Quo – This includes objectives that the area of mature forest in each of eight vegetation communities be maintained above 12% of the total area of each community as defined in the 1982 provincial inventory.[3]

- Maintain Under-represented Stand Types – This maintains the six under-represented stand types at or above their current abundance; these six being ones which have become less abundant over the past 70 years. This option prevents further reduction of these types which are important elements of the Acadian forest character.

- Restore Under-represented Stand Types – This returns the six under-represented stand types over time to their abundance levels as estimated for 1940. Relative to today, it increases the representation of stand types characteristic of the Acadian forest.

- Increase Under-represented Stand Types – This option increases the abundance of under-represented stand types to twice the levels of the 1940 benchmark. This reflects the possibility that such types had already been reduced below historical levels by 1940. It also promotes a forest with increased composition of those species judged to be better adapted to future climatic conditions forecast to occur in New Brunswick as a result of climate change.

Impacts

In addition to influencing the abundance of stand types, the forest composition options affect wood supply and the mix of prescriptions employed in the forest.

- The forest composition options are successful in raising the abundance of under-represented types, which mostly are those dominated by late-successional species (Fig. 4-17). This increase, brought about by harvest and silviculture treatments that favour these species, is accompanied by a decrease in balsam fir and intolerant mixed types.

- Use of treatments to create these compositional changes is reflected in the management history of the forest (Fig. 4-18). As abundance targets for under-represented types increase across the options, the area of spaced and uneven-aged stands increases; planted and untreated even-aged stands decrease in area. The species control necessary to meet forest composition objectives is exercised by spacing to retain target species where they exist in young stands and by uneven-aged harvesting to regenerate desired species which are not favoured by even-aged harvesting.

- The forest composition options have negative short-term wood supply consequences (Fig. 4-19), largely because uneven-aged harvesting delays the availability of volume for harvest by retaining unharvested trees between entries. Delaying volume availability past the time when minimum inventory levels occur reduces short-term wood supply.

Fig. 4-17 – Area (%) by forest type at forecast year 100

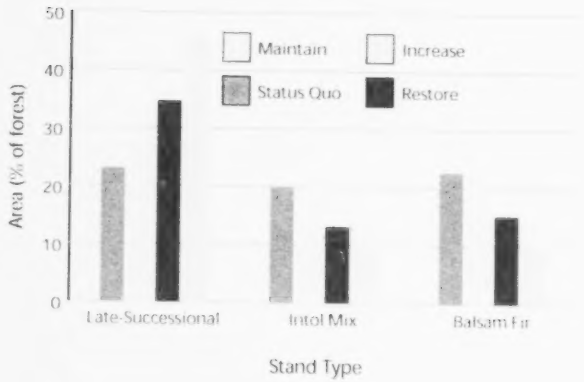


Fig. 4-18 – Area (%) by management history at forecast year 100

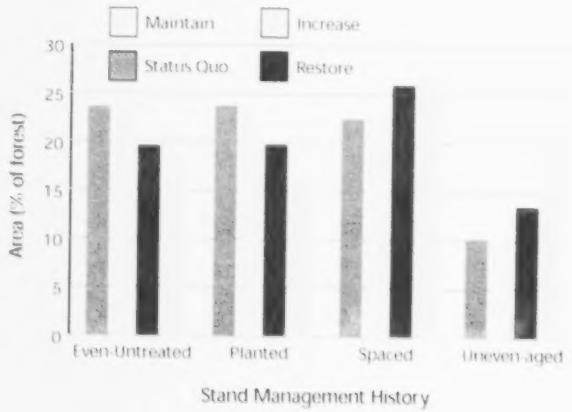
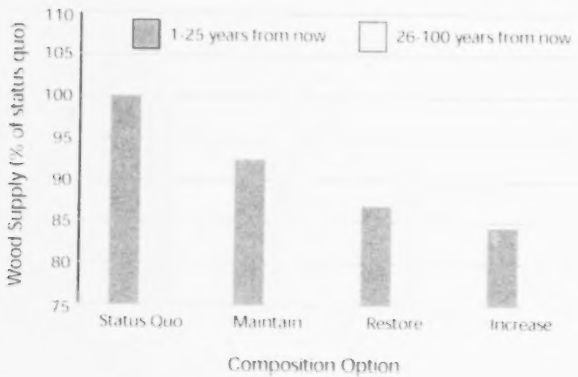


Fig. 4-19 – Spruce/fir log-potential wood supply in short and long term as % of status quo



Part 5
Management Alternatives and Outcomes

Report of the New Brunswick Task Force
on Forest Diversity and Wood Supply

Selected Alternatives

Management alternatives can be defined by selecting options for each of the seven cornerstone issues in combinations designed to achieve a certain set of objectives. With each of the seven issues having several options, there exists a very large number of possible alternatives.

From the many possible alternatives, the Task Force chose eight for detailed analysis and discussion (Table 5-1). This set is by no means exhaustive, but is broad and varied both in the relative emphasis given to diversity and wood supply objectives and in the means for achieving them.

For each of these eight alternatives, forest development was forecast over a 100 year time horizon using methods described in Part 3, and the outcomes defined in previously outlined measures relating to wood-based business opportunity, forest diversity, and socio-economic impact.

The balance of this chapter presents and discusses those results. Alternatives are first examined individually, and then collectively, to provide a clear picture of each alternative and how it compares to others.

A common format is used in the discussion of the individual alternatives, including graphical illustration of six key measures.

- The upper left figure (e.g. Fig. 5-1) shows the total and log-potential spruce/fir wood supply (million m³/yr) over the 100 year time horizon, which reveals both the magnitude of supply and the timing of potential increases under the alternative. For comparison, the total and log-potential supply under the status quo alternative are plotted on the same figure.

- The upper right figure (e.g. Fig. 5-2) presents the log-potential supply of the other five major species groups.

Table 5-1 – Summary of alternative forest management strategies defined by selected options for each of seven cornerstone issues. Options are as defined in Part 4.

Alternative	Wood Supply Priority	Protected Natural Area (%)[1]	Conservation Area (%)[1,3]	Minimum Old Forest Area (%)[1]	Maximum Plantation Area (%)[1]	Harvest Treatments[2]	Forest Composition
SQ	spruce/fir	4	30	25[5]	25	non-clearcutting where late-successional species individually >50% (current policy)	maintain vegetation communities[4]
A	equal	22	37	40	0	emulate natural disturbance	restore under-represented types
B	equal	10	30	40	13	restore late-successional species by non-clearcutting where their combined content >20%	increase under-represented types to above 1940 levels
C	spruce/fir	13	25	25	19	restore late-successional species by non-clearcutting where their combined content >20%	restore under-represented types
D	spruce/fir	13	25	25[5]	37	maintain late-successional species by non-clearcutting where their combined content >50%	maintain under-represented types
E	spruce/fir	10	20	25[5]	37	non-clearcutting where late-successional species individually >50% (current policy)	maintain vegetation communities[4]
F	equal	10	20	25[5]	25[6]	emulate natural disturbance	maintain vegetation communities[4]
G	spruce/fir	16	30	25[5]	25	emulate natural disturbance	maintain under-represented types

1. Expressed as percent of the total Crown forest area of 2.99 million ha
2. Species classified as "late-successional" in this report include cedar, hemlock, red spruce, white pine, sugar maple, and yellow birch. Percentages based on stand volume
3. Includes protected area
4. Vegetation communities, which are groups of stand types defined by species composition, are the basis for objectives used in current management strategies
5. These alternatives are based on the status quo and thus have no explicit old forest targets as old forest is defined in this report. As a result of other objectives old forest is maintained at or above 25% of the forest
6. Gross plantation area is set at 25%, but under this alternative 10% of all harvest areas is left as permanent retention; thus actual area planted equals 22.5% of total forest

The average supply is shown for the short-term (years 1-25) and for the long-term (years 26-100 of the planning horizon). For comparison, the long-term supply under the status quo alternative is plotted on the same figure.

- The middle left figure (e.g. Fig. 5-3) shows the distribution of percent forest area by management history at year 50 (calendar year 2062) of the 100 year forecast. In all cases the denominator for the percentages is the total Crown forest area of 2.99 million ha. Unmanipulated stands reported in the figure are ones in which no harvesting has occurred since 1930 and which remain unharvested up to the reported forecast year. Because these stands are least affected by timber management activities, they represent the most "natural" of conditions in the forest. Uneven-aged stands reported in the figure are those in which harvest prescriptions have been implemented to promote the development of multiple age classes of trees within stands. Some stand types naturally develop multiple age classes, however "uneven-aged" is used here to distinguish stands in which harvest prescriptions have been purposefully employed to create that condition.

- The middle right figure (e.g. Fig. 5-4) shows the percent abundance of old forest, subdivided by mature and late-successional conditions (Appendix 8), over time for the 100 year forecast period. The denominator is the total Crown forest area.

- The lower left figure (e.g. Fig. 5-5) shows the percent abundance by eight stand types (Appendix 3) at the start of the forecast (2012), 50 years hence (2062), and 80 years hence (2092). It is important to show the change over a long time horizon, as it takes time for treatments to affect sufficient area for forest-level impacts on composition to fully appear. The denominator is total Crown forest area.

- The lower right figure (e.g. Fig. 5-6) presents the structure of the forest at the end of the 100 year planning horizon by broad age classes and three condition categories, namely: unmanipulated, planted, or managed for natural regeneration. By definition, uneven-aged stands are not characterized by a single age; they are shown as a separate category on the x-axis.

Eight alternatives are presented here, a small fraction of the thousands which can be devised from all unique combinations of the various options for each of seven cornerstone issues. Thus, some readers are bound to see in these eight alternatives some which they find interesting, but in which they would prefer a change to one of its options.

By referring back to Part 4 for the issue in question, inference can be made about the impact of a contemplated change; if not in quantitative terms because of interactions between options, then at least in terms of which indicators are likely to increase and which to decrease. For example, if one sees an alternative in which they would prefer a reduced area in plantations, it can be inferred from the discussion of plantation impacts in Part 4 that such a change would:

- have no effect on short-term spruce/fir supply, but decrease the potential for expansion in the future (Fig. 4-11);
- decrease planting area in the future to the target level (Fig. 4-12)
- have little effect on old and unmanipulated forest area.

Using the results and discussion in Part 4 to "interpolate" in this way should enable informed consideration of alternatives outside the eight presented here.

Status Quo

Description

This alternative reflects forest management on Crown land as conducted under current government policy and includes both diversity and wood supply objectives. These have evolved over time and are fully described in the Government's documents "Our Shared Future"[1] and "Objectives and Standards for the New Brunswick Crown Forest for the 2007-2012 Period".[2]

- The primary wood supply objective is to maximize the sustainable supply of spruce/fir in the short-term, followed, in decreasing order of priority, by maximizing long-term spruce/fir supply and maximizing hardwood (all species combined). These objectives include a non-declining harvest policy which allows wood supply increases over time, but which disallows decreases.
- There are no wood supply objectives set for softwood species other than spruce, fir, and jack pine, and none set for individual hardwood species. Spruce/fir quality is indirectly controlled by a limit on the proportion of volume harvested in trees of small size.
- Non-clearcut harvesting must be conducted in stands where 50% or more of the volume is (individually) tolerant hardwood, cedar, white pine, red spruce, or red pine.
- Area of suitable habitat is maintained at levels deemed necessary to support viable populations of all native forest vertebrates, and to maintain current deer populations.
- The area of mature vegetation communities is maintained above 12% of the forest area and riparian buffers are a minimum of 30m to protect water quality and maintain tree cover in riparian locations.
- Four percent of the total forested area is included in a network of protected areas.

Outcomes

- The total and log-potential wood supply of spruce/fir increase 60% by year 50 (Fig. 5-1). This results largely from planting and spacing treatments; by year 50, plantations and spacings make up 22 and 21% of the forest, respectively (Fig. 5-3).
- The absence of objectives for non-spruce/fir species results in highly variable harvest levels of those species and, except for tolerant hardwood, decline of log-potential wood supply in the long-term (Fig. 5-2).
- Over time, treatments implemented to meet wood supply objectives change forest composition by increasing balsam fir and spruce/fir types, and decreasing tolerant mixedwoods (Fig. 5-5).
- In the long-term, old forest makes up 35% of the total area (Fig. 5-4) and the forest age structure develops two distinct features (Fig. 5-6). By year 100, 58% of the forest is even-aged and less than 50 years old, and 21% is unmanipulated and more than 150 years old. Few even-aged stands managed for timber exceed 100 years of age.

Summary of Status Quo Management Settings

Wood Supply	spruce/fir
Protected Area	4%
Conservation Forest Area	30%
Minimum Old Forest Area	25%
Maximum Plantation Area	25%
Harvest Treatments	non-clearcutting where late-successional species individually >50% (current policy)
Forest Composition	maintain vegetation communities

Fig. 5-1 – Spruce/fir wood supply vs status quo (SQ)

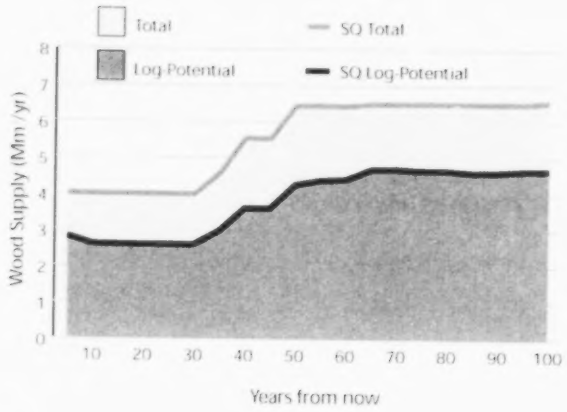


Fig. 5-2 – Log-potential wood supply (SQ)

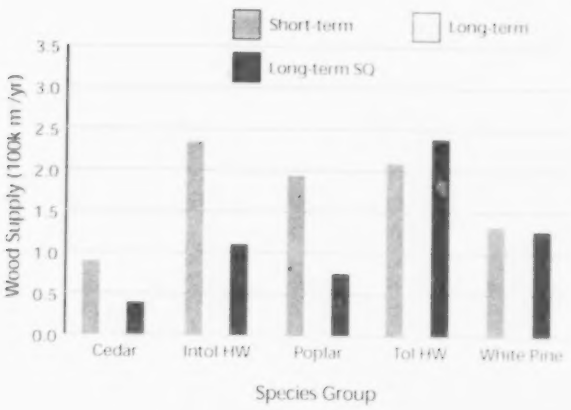


Fig. 5-3 – Area by management history at forecast year 50 (SQ)

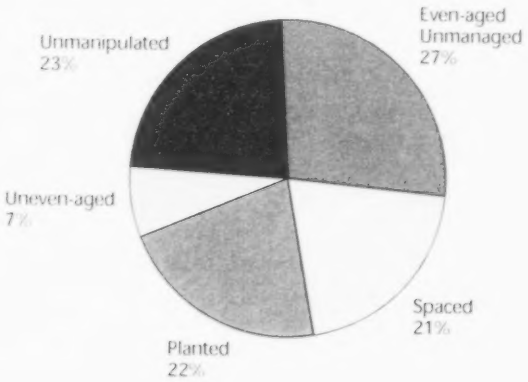


Fig. 5-4 – Old forest abundance over time (SQ)

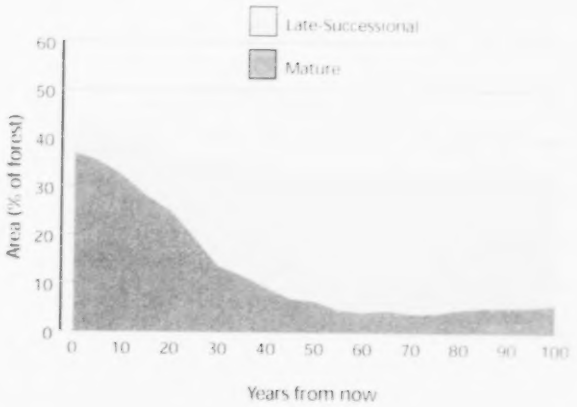


Fig. 5-5 – Forest stand type abundance (SQ)

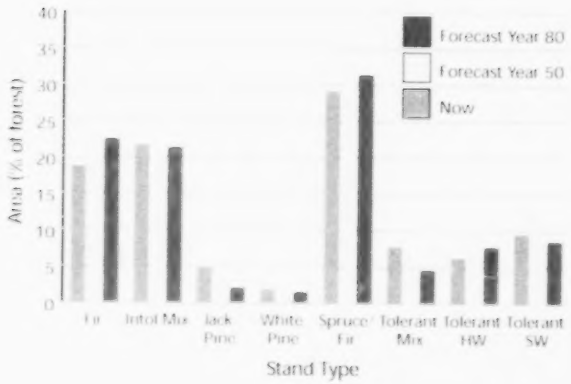
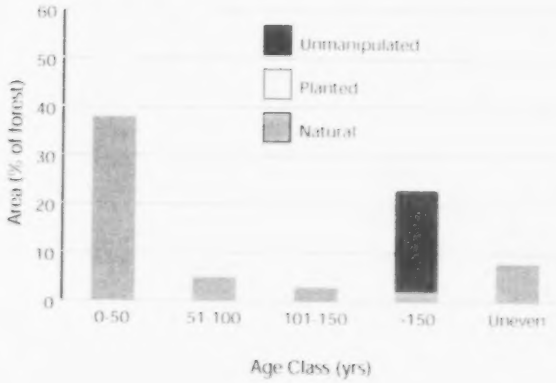


Fig. 5-6 – Age class structure at forecast year 100 (SQ)



Alternative 'A'

Description

This alternative has conservation as the over-riding objective, which it achieves primarily through increased allocation of forest to conservation zones and implementation of low-intensity management regimes on the portion of the forest managed for timber production.

- The wood supply objective places equal priority on all species groups.
- Conservation objectives are met through increasing the conservation land base to 37% of the total forest area, and increasing protected areas to reach "full representation" (22% of the total forest) as proposed by World Wildlife Fund-Canada.
- Conservation goals are further met by increasing old forest targets, and eliminating plantations over time. No new area is planted and once plantations are harvested, the area is left to regenerate naturally.
- On the forest area managed for timber production, treatments are employed to maintain some of the characteristics likely to result from natural disturbance. This varies by stand type, but includes managing for complex stand structures by creating multiple age classes within stands and permanently retaining significant amounts of unharvested interior patches to provide large live trees, snags, and coarse woody debris over time.
- The abundance of under-represented stand types is gradually increased to estimated 1940 levels by year 60.

Outcomes

- Because of the large area assigned to conservation forest, the wood supply of all species drops relative to the status quo. The drop is most pronounced (almost 40%) in spruce/fir (Figs 5-7).
- For the same reason, much of the forest area (29%) remains unmanipulated 50 years hence (Fig. 5-9), and old forest steadily rises to almost 55% of the total area by the end of the planning horizon (Fig. 5-10).
- Because no more plantations are established, planted area drops to 5% by year 50. Spacing is used more extensively to meet wood supply objectives, and after 50 years, spaced area increases to 29% of the total forest (Fig. 5-9).
- Forest composition is affected in two ways. Restriction on planting increases fir and decreases spruce/fir and intolerant mixedwood types. Increased use of non-clearcut harvesting maintains the tolerant stand types in generally constant abundance (Fig. 5-11).
- The forest allocation to conservation zones and cessation of planting creates a forest structure dominated by unplanted, even-aged stands less than 50 years old and unmanipulated stands greater than 150 years old. Each makes up nearly one-third of the forest (Fig. 5-12).

Summary of Alternative 'A' Management Settings

Wood Supply	equal priority
Protected Area	22%
Conservation Forest Area	37%
Minimum Old Forest Area	40/12%
Maximum Plantation Area	0%
Harvest Treatments	emulate natural disturbance
Forest Composition	restore under-represented types

Fig. 5-7 – Spruce/fir wood supply vs status quo ('A')

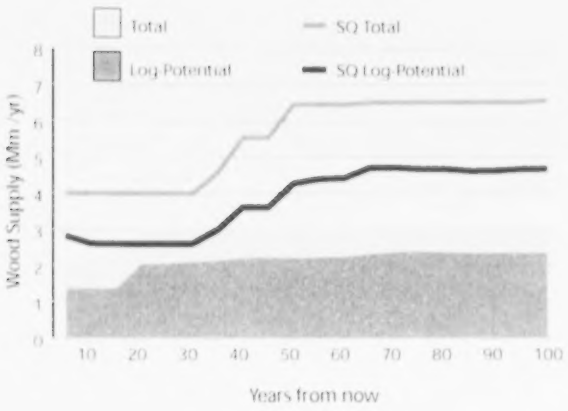


Fig. 5-8 – Log-potential wood supply ('A')

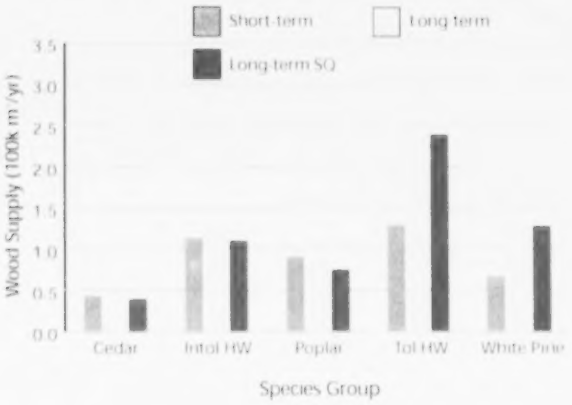


Fig. 5-9 – Area by management history at forecast year 50 ('A')

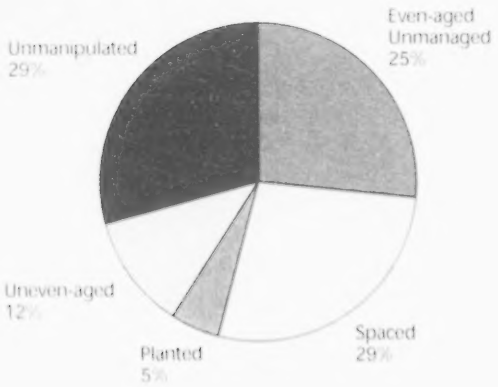


Fig. 5-10 – Old forest abundance over time ('A')

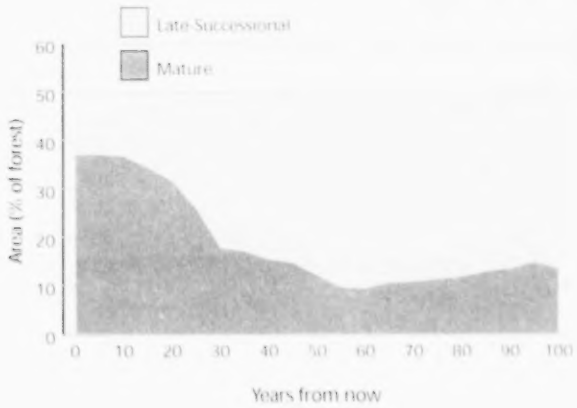


Fig. 5-11 – Forest stand type abundance ('A')

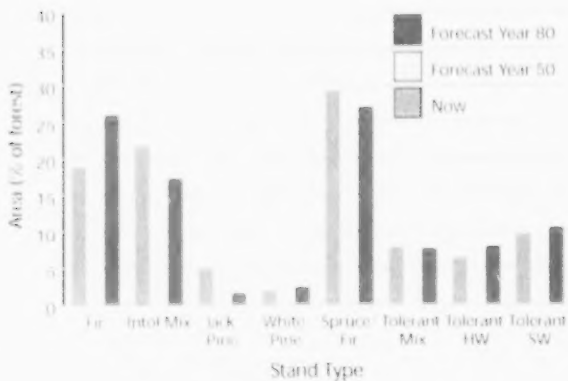
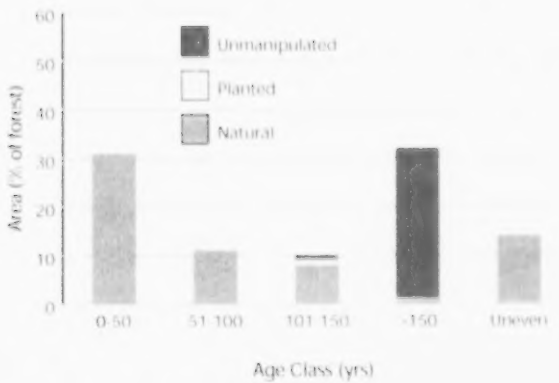


Fig. 5-12 – Age class structure at forecast year 100 ('A')



Alternative 'B'

Description

This alternative focuses on changing the forest condition to increase forest diversity in all its dimensions, including wood supply, species composition, stand type abundance, and amount of old forest.

Change in forest condition is brought about through active management, and conservation values are enhanced across the entire forest by resulting increases in the diversity, complexity, and age of stands which exist in the forest.

- The wood supply objectives are broadened by placing equal priority on all species groups.
- The area of stands growing to old forest condition is increased by establishing more protected area (from 4 to 10%) and by increasing old forest targets to 40% of the forest, including 12% for the late-successional condition.
- Non-clearcut harvesting is required in all stands with 20% or more volume content of late-successional species to increase abundance of those species over time.
- Plantation area is kept at 13% of the forest. Harvested plantations can be replanted, but no new plantation area is permitted.
- The abundance of under-represented types is set to increase over time to twice the levels estimated in the 1940 benchmark. This target strongly favours creation and maintenance of these types, many of which are ones expected to fare well under anticipated future climate conditions (Appendix 12).

Outcomes

- The focus on diversity changes the wood supply species mix; relative to the status quo spruce/fir supply is decreased significantly, by 36% and 45% in the short and long-terms, respectively (Fig. 5-13). Other species are favoured and their supply increases over time, especially tolerant hardwood and white pine (Fig. 5-14).
- Distribution of stand area by management history responds strongly to the elements of this alternative (Fig. 5-15). Over one-quarter of the forest remains unmanipulated 50 years hence and stands under uneven-aged management are in greater abundance than plantations (16% vs 13%).
- Non-clearcut harvesting and spacing (selecting crop species) gradually shift forest composition; fir, spruce/fir, and intolerant types decline in abundance, as white pine and the three tolerant types (hardwood, mixedwood, and softwood) increase, in combination nearly doubling over the planning horizon (Fig. 5-17).
- Lower overall harvest levels, combined with greater use of non-clearcut harvesting and higher old forest targets, result in 50% of the forest area in old condition (Fig. 5-16) and a relatively diverse forest structure (Fig. 5-18). Uneven-aged and even-aged forest greater than 150 years old make up half the forest.

Summary of Alternative 'B' Management Settings

Wood Supply	equal priority
Protected Area	10%
Conservation Forest Area	30%
Minimum Old Forest Area	40/12%
Maximum Plantation Area	13%
Harvest Treatments	restore late-successional species by non-clearcutting where their combined content >20%
Forest Composition	increase under-represented types to above 1940 levels

Fig. 5-13 – Spruce/fir wood supply vs status quo ('B')

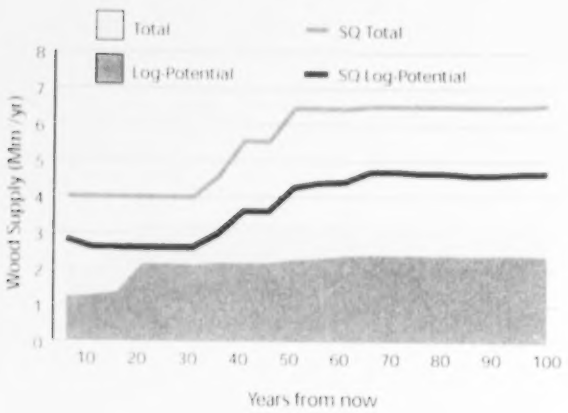


Fig. 5-14 – Log-potential wood supply ('B')

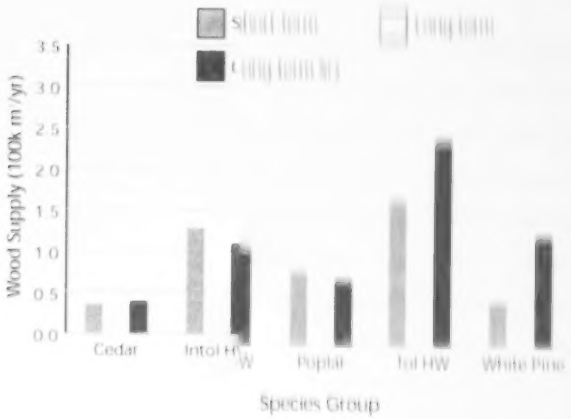


Fig. 5-15 – Area by management history at forecast year 50 ('B')

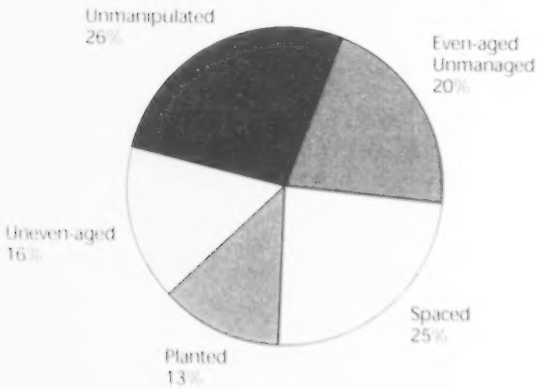


Fig. 5-16 – Old forest abundance over time ('B')

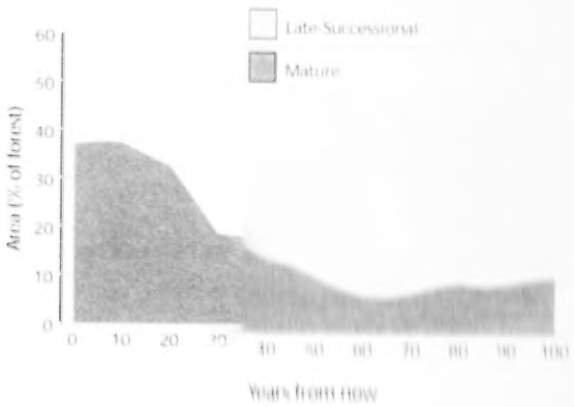


Fig. 5-17 – Forest stand type abundance ('B')

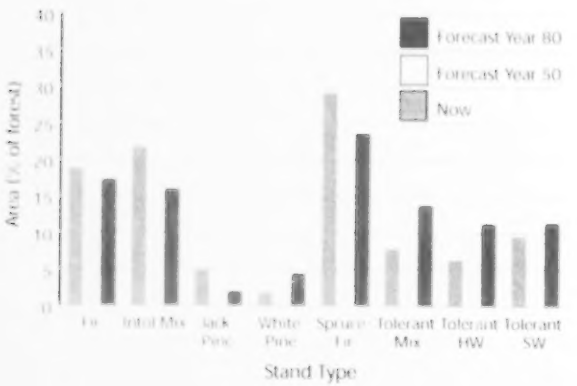
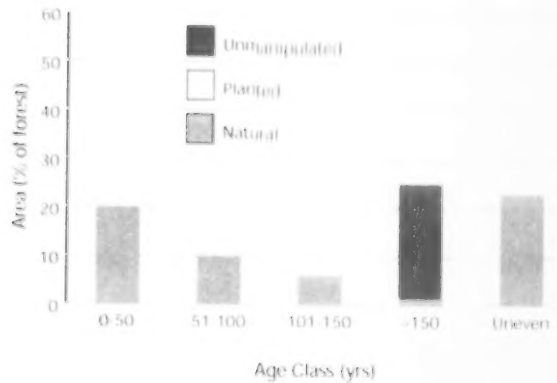


Fig. 5-18 – Age class structure at forecast year 100 ('B')



Alternative 'C'

Description

This alternative increases the emphasis on diversity objectives relating to the amount of old forest and protected area, and to the abundance of late successional species and stand types. It partly offsets the wood supply impacts by reducing the conservation forest area.

- Wood supply priority is placed on spruce/fir log potential while ensuring a sustainable supply of all other species groups.
- Protected area is increased from 4% to 13% of the forest area; the increase being drawn from both general forest and habitat zones and configured in a mix of large and small blocks.
- Treatments are geared to favour late-successional species and complex stand types, maintaining them where currently abundant, and increasing them where their present abundance is likely less than their pre-1940 abundance.
- Five percent permanent retention is maintained in all harvested stands to provide legacy structures over time.
- To mitigate the negative wood supply impacts of increased diversity objectives, the conservation forest area is reduced to 25% by assigning to general forest those areas making the least contribution to conservation objectives defined under current policy.

Outcomes

- The log potential spruce/fir supply is 11% less than that under the status quo in the short term. The supply increases over time by 52%, but the gain is limited by the 19% cap on plantation area (Fig. 5-19).
- The treatments that favour late successional species result in significant long-term increases in supply of log potential white pine and tolerant hardwood (Fig. 5-20).
- The objectives combine to result in an even distribution of area by management history. Plantations, spacings, uneven-aged, unmanaged even-aged, and unmanipulated stands all occur in roughly equal proportion after 50 years (Fig. 5-21).
- Objectives favouring late-successional species invoke treatments that create a long-term increase of the tolerant hardwood, softwood, and mixedwood stand types, and a decrease of balsam fir and intolerant mixedwood (Fig. 5-23).
- Old forest drops moderately from its present level and in the long-term makes up 35% of the total forest area (Fig. 5-22). The forest age structure reflects the diversity-oriented options: 40% of the forest is uneven-aged or unmanipulated forest older than 150 years, and 46% is younger than 50. However, as with most strategies, little area managed for timber on an even-aged basis is older than 100 years (Fig. 5-24).

Summary of Alternative 'C' Management Settings

Wood Supply	spruce/fir priority
Protected Area	13%
Conservation Forest Area	25%
Minimum Old Forest Area	25%
Maximum Plantation Area	19%
Harvest Treatments	restore late-successional species by non-clearcutting where their combined content >20%
Forest Composition	restore under-represented types

Fig. 5-19 – Spruce/fir wood supply vs status quo ('C')

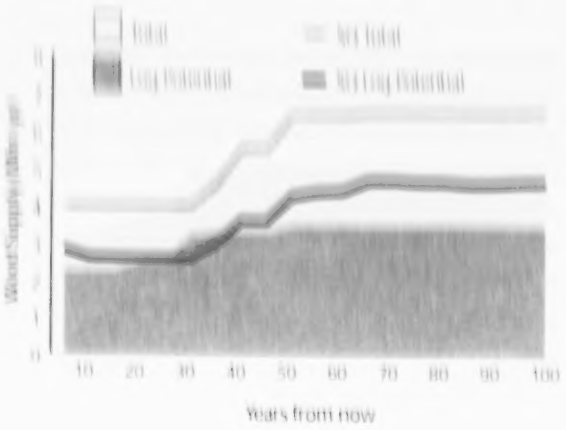


Fig. 5-20 – Log-potential wood supply ('C')

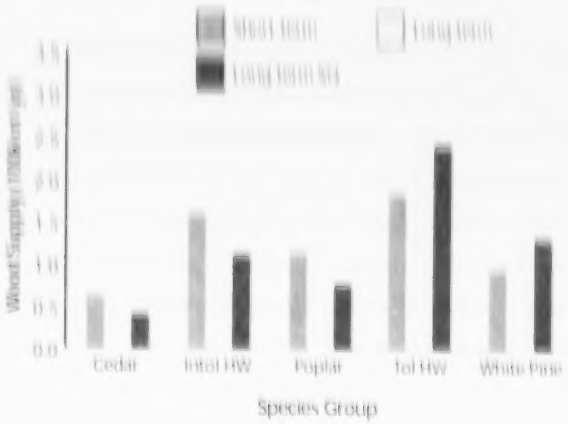


Fig. 5-21 – Area by management history at forecast year 50 ('C')

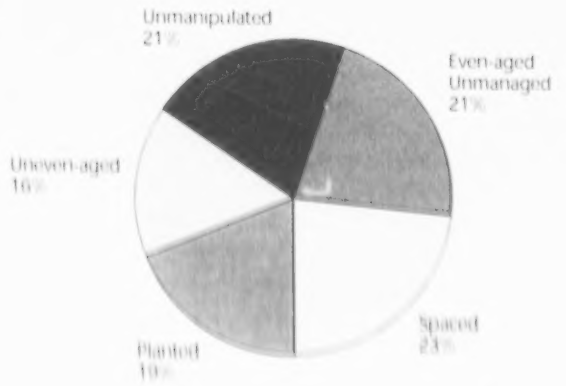


Fig. 5-22 – Old forest abundance over time ('C')

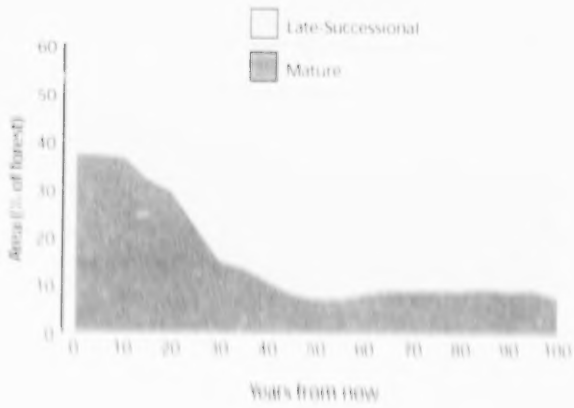


Fig. 5-23 – Forest stand type abundance ('C')

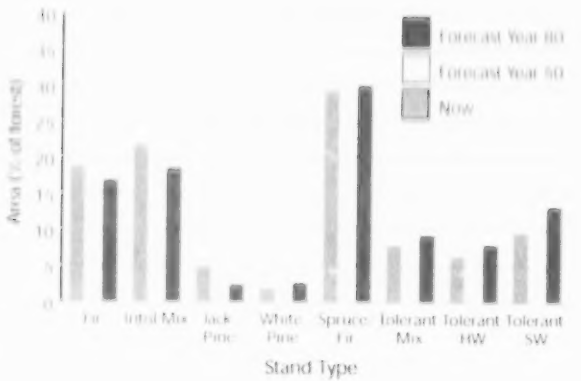
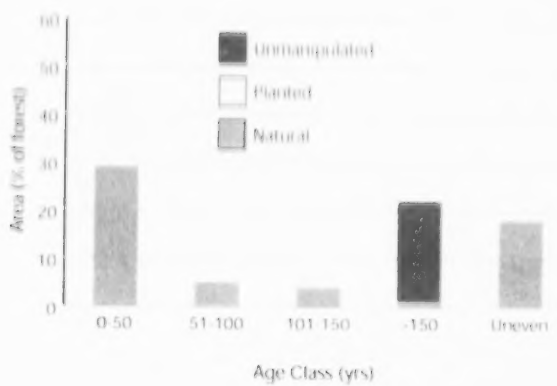


Fig. 5-24 – Age class structure at forecast year 100 ('C')



Alternative 'D'

Description

This alternative includes objectives to increase forest diversity, while introducing measures to mitigate the negative wood supply consequences of those objectives.

- The wood supply objective places top priority on log potential volume of spruce/fir, but ensures a sustained supply of all other species groups.
- Diversity goals are partly addressed by increasing the protected area from 4% to 13% of the forest so that more area develops naturally, unaffected by timber management practises.
- Treatments are implemented to maintain the presence of late-successional species where they are relatively abundant today (collectively making up >50% of a stand) and 5% permanent retention area is included in each harvest prescription.
- Under-represented stand types (relative to the 1940 benchmark) are not allowed to decline from their present level.
- To mitigate negative wood supply consequences of these objectives, plantation area is allowed to triple by year 50 to 37% of the total forest.
- The total conservation forest area is reduced to 25% by assigning to the general forest those areas deemed to contribute least to conservation objectives of the current policy.

Outcomes

- The wood supply mitigation measures maintain the spruce/fir supply at 94% of the status quo in the short term. However, the expanded plantation area allows this slightly reduced short term level to more than double 55 years in the future (Fig. 5-25).
- Supply of log-potential tolerant hardwood and white pine, and the abundance of stand types dominated by these species, increases modestly in the long-term as a result of treatments that favour these species (Fig. 5-26).
- By year 50, 37% of the landbase is in plantations and 9% is in spacings. Unmanipulated and uneven-aged stands together make up 31% of the forest area (Fig. 5-27).
- The spruce/fir type increases while balsam fir and intolerant hardwood types decrease. This results from the high level of planting, which replaces the latter two types with spruce/fir (Fig. 5-29).
- Old forest area drops to just over 30% of the forest (Fig. 5-28) and the forest structure in the long-term has 50% of the area in stands less than 50 years old. Given the 37% plantation cap, over half of the even-aged forest is in plantations. The diversity-oriented facets of this alternative result in one-third of the forest area being uneven-aged or unmanipulated and older than 150 years (Fig. 5-30).

Summary of Alternative 'D' Management Settings

Wood Supply	spruce/fir priority
Protected Area	13%
Conservation Forest Area	25%
Minimum Old Forest Area	25/8%
Maximum Plantation Area	37%
Harvest Treatments	maintain late-successional species by non-clearcutting where their combined content >50%
Forest Composition	maintain under-represented types

Fig. 5-25 – Spruce/fir wood supply vs status quo ('D')

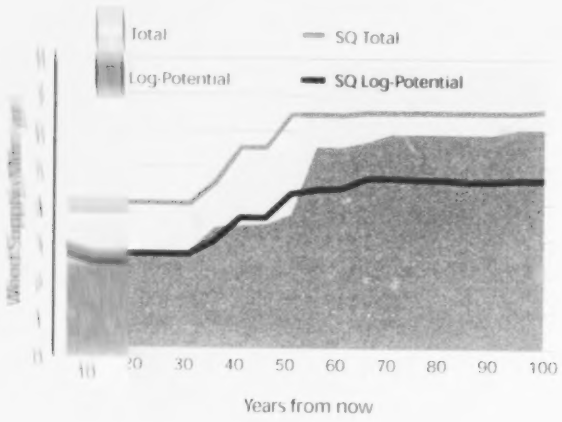


Fig. 5-26 – Log-potential wood supply ('D')

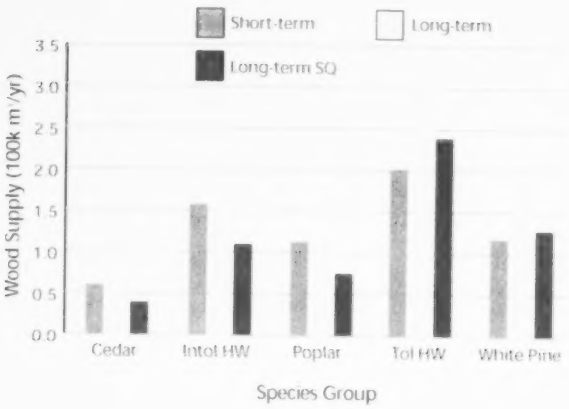


Fig. 5-27 – Area by management history at forecast year 50 ('D')

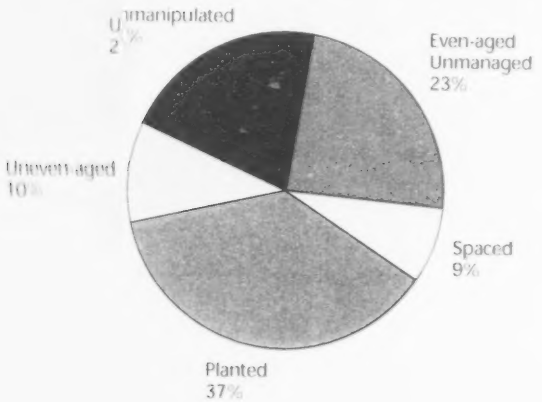


Fig. 5-28 – Old forest abundance over time ('D')

Fig. 5-29 – Forest stand type abundance ('D')

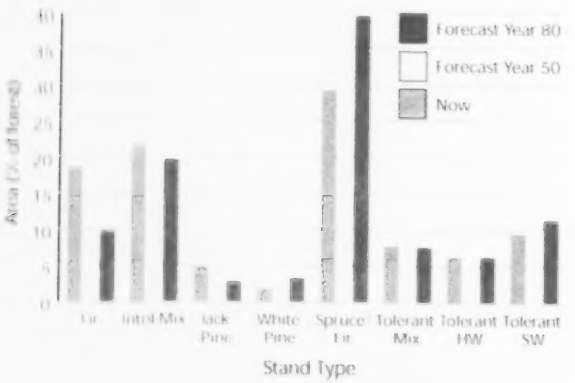
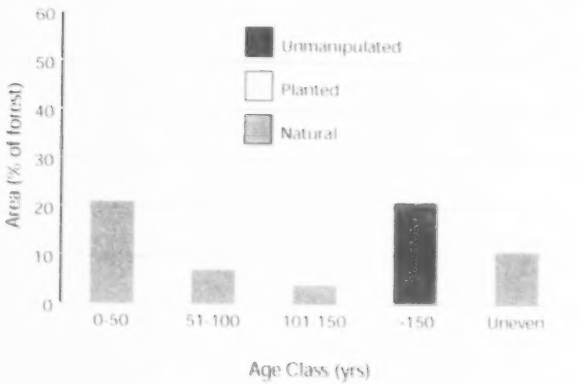


Fig. 5-30 – Age class structure at forecast year 100 ('D')



Alternative 'E'

Description

This alternative reflects the recommendations of the report by the New Brunswick Task Force on Self-Sufficiency. It has the primary objectives of increasing current and future wood supply through reduction of conservation forest area and increasing the area in plantations.

- Wood supply priority is placed on log-potential production of spruce/fir. A sustainable supply is maintained of all other species groups.
- To allow an immediate increase in harvest, the area of conservation zones is reduced from 30% to 20% of the total forest area.
- The amount of protected area is increased from 4% to 10%. The additional area given protected status is drawn entirely from existing habitat zones; thus, it is in small-block configuration, causing no reduction in general forest area.
- To support a future spruce/fir supply increase, the area of plantations is allowed to triple by year 50 to 37% of the total forest area.
- Non-clearcut harvesting must be conducted in stands where 50% or more of the volume is (individually) tolerant hardwood, cedar, white pine, red spruce, or red pine.

Outcomes

- The reduction in conservation forest area and 37% ceiling on plantation area result in short-term (4%) and long-term (25%) wood supply increases of log-potential spruce/fir above the status quo. The wood supply more than doubles after 50 years (Fig. 5-31).
- Wood supply of white pine increases 50% over the long-term, and wood supply for all non-spruce/fir species exceeds the status quo because of the increase in general forest area (Fig. 5-32). The increase in protected area has minimal wood supply effect because the additional area is taken entirely from existing habitat zones.
- After 50 years, unmanipulated and uneven-aged stands make up 28% of the total forest while plantations and spacings make up 37% and 8%, respectively (Fig. 5-33).
- Forest composition changes as a result of the high level of planting; the spruce/fir type, created by planting, increases while fir and intolerant hardwood types decrease (Fig. 5-35).
- Collectively, tolerant softwood, hardwood, and mixed wood types drop roughly 5% in area over time (Fig. 5-35).
- Old forest drops to 31% of the forest area by year 45 and thereafter remains stable (Fig. 5-34). In the long-term, 56% of the forest is less than 50 years old, over half of which is planted. There is little forest in the 101-150 year age class. Uneven-aged and unmanipulated stands greater than 150 years old make up 27%, which results from the reduced conservation area and use of status quo composition and treatment objectives (Fig. 5-36).

Summary of Alternative 'E' Management Settings

Wood Supply	spruce/fir priority
Protected Area	10%
Conservation Forest Area	20%
Minimum Old Forest Area	25%
Maximum Plantation Area	37%
Harvest Treatments	non-clearcutting where late-successional species individually >50% (current policy)
Forest Composition	maintain vegetation communities

Fig. 5-31 – Spruce/fir wood supply vs status quo ('E')

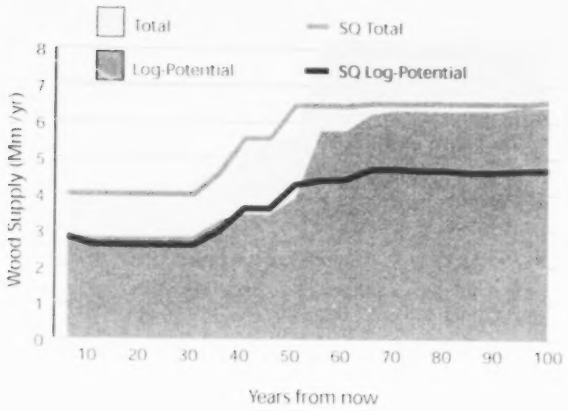


Fig. 5-32 – Log-potential wood supply ('E')

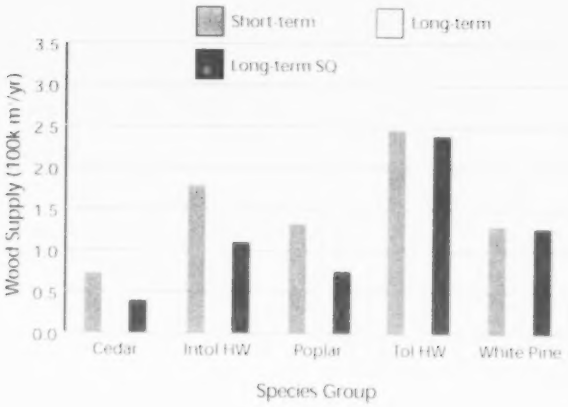


Fig. 5-33 – Area by management history at forecast year 50 ('E')

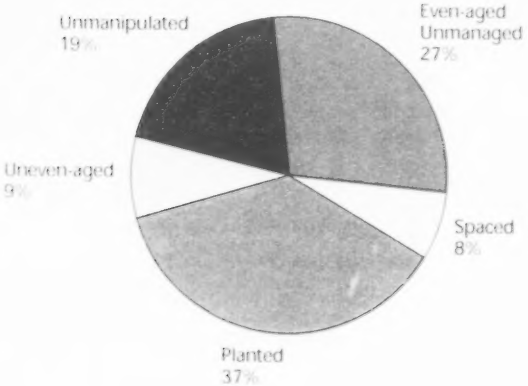


Fig. 5-34 – Old forest abundance over time ('E')

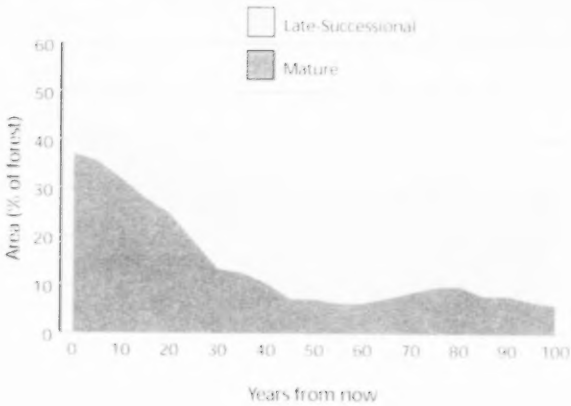


Fig. 5-35 – Forest stand type abundance ('E')

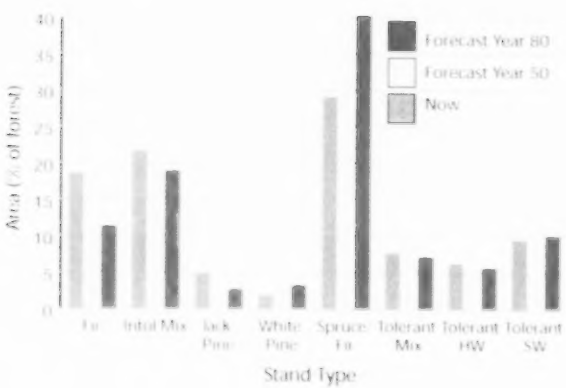
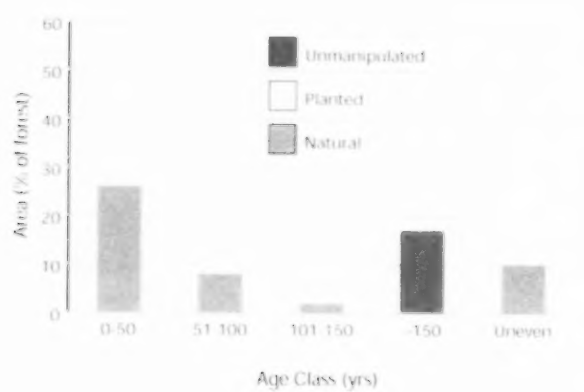


Fig. 5-36 – Age class structure at forecast year 100 ('E')



Alternative 'F'

Description

This alternative is designed so that most stands in the forest are managed to jointly satisfy diversity and timber supply objectives. It achieves this by reducing the forest area in conservation zones and making extensive use of low-intensity harvesting across a much larger proportion of the forest.

- The wood supply objective places equal priority on all species.
- In recognition that some conservation values are not compatible even with low-intensity harvesting, protected area is increased to 10% of the forest. The area is drawn from existing habitat zones and is in relatively small blocks.
- With the exception of riparian buffers and deer wintering areas, which have important site-specific functions, all remaining habitat zones are merged into the general forest. The enlarged general forest is managed to retain habitat values while permitting some timber harvesting.
- To maintain habitat and diversity values in harvested stands, non-clearcut harvesting is required in all eligible stand types, and all harvest prescriptions leave 10% to 20% of the stand permanently unharvested. This provides an ongoing supply of large trees, snags, and coarse woody debris within each stand.
- Plantation area is allowed to make up 25% of the forest, but all plantations include 10% permanent retention to provide long-term within-stand diversity; thus, net planted area is 22.5% of the total forest area.

Outcomes

- Making more area available for harvest, even with low intensity harvest prescriptions, results in a log-potential spruce/fir supply roughly equal to that of the status quo in the short-term and exceeding it by 5% in the long-term (Fig. 5-37). This alternative results in the highest wood cost of all alternatives, as illustrated in the next section.
- Heavy reliance on non-clearcut prescriptions favours late-successional species, as reflected in the gains in log-potential wood supply for white pine and tolerant hardwood (Fig. 5-38), and results in 19% of the forest being managed on an uneven-aged basis after 50 years (Fig. 5-39).
- The area of unmanipulated forest drops to 15%, as even low intensity prescriptions manipulate the forest (Fig. 5-39).
- The forest composition is relatively unchanged, with plantation establishment resulting in a modest increase in the spruce/fir type and corresponding reductions in the balsam fir and intolerant mixedwood types (Fig. 5-41).
- Old forest is kept relatively stable at just under 40% of the total area and is made up of roughly equal amounts of mature and late-successional forest (Fig. 5-40). Low intensity treatments maintain mature conditions, but residual stand conditions do not meet late-successional criteria. The forest structure has 10% more area in stands younger than 50 years than the combined area of uneven-aged stands and those older than 150 years. Least abundant are even-aged stands 101 to 150 years old (Fig. 5-42).

Summary of Alternative 'F' Management Settings

Wood Supply	equal priority
Protected Area	10%
Conservation Forest Area	20%
Minimum Old Forest Area	25%
Maximum Plantation Area	25%
Harvest Treatments	emulate natural disturbance
Forest Composition	maintain vegetation communities

Fig. 5-37 – Spruce/fir wood supply vs status quo ('F')

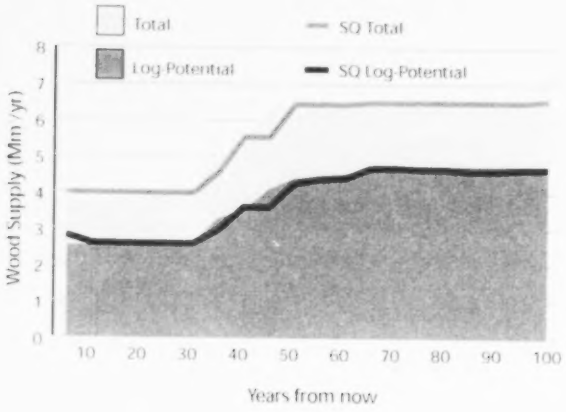


Fig. 5-38 – Log-potential wood supply ('F')

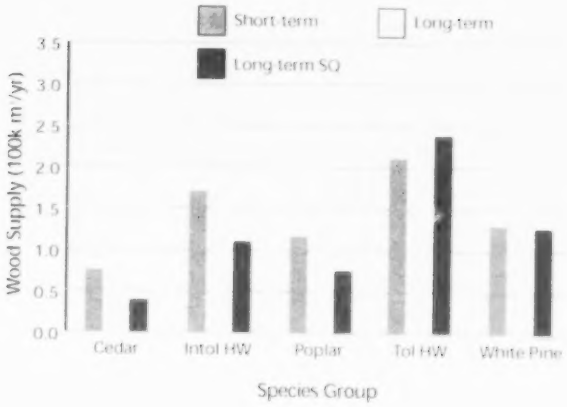


Fig. 5-39 – Area by management history at forecast year 50 ('F')

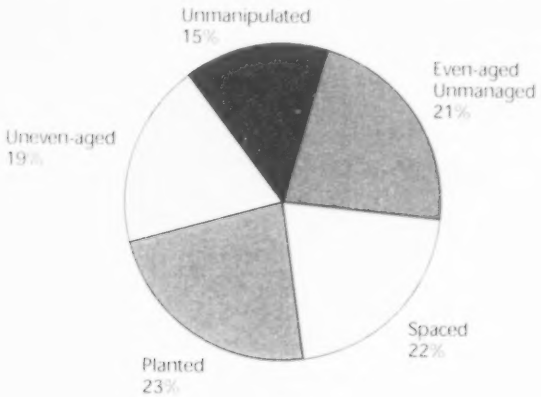


Fig. 5-40 – Old forest abundance over time ('F')

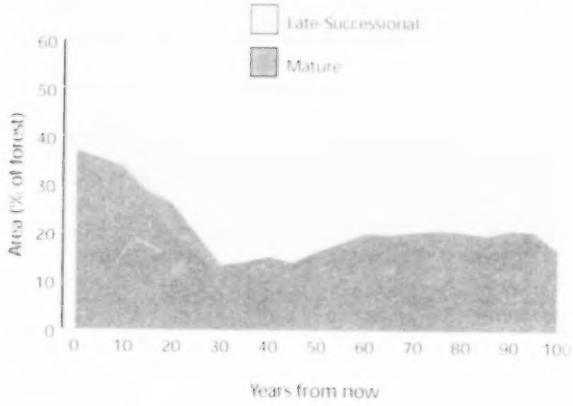


Fig. 5-41 – Forest stand type abundance ('F')

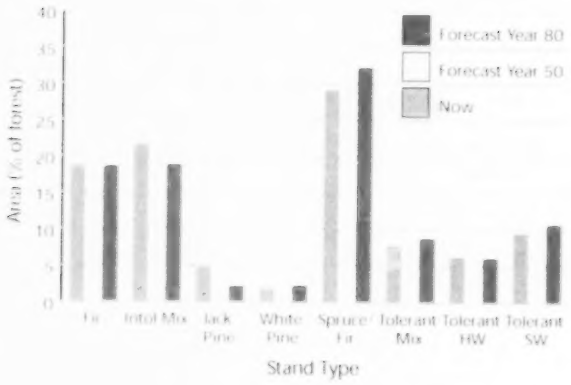
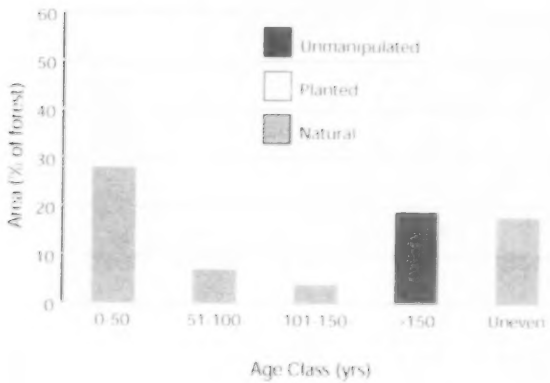


Fig. 5-42 – Age class structure at forecast year 100 ('F')



Alternative 'G'

Description

This option divides the forest into three zones: one primarily to provide diversity values; one primarily to provide wood supply values; and one to provide both. This is intended to combine the benefits of single-objective management in the first two zones with those of multiple-objective management in the third as an alternate means to meet overall wood supply and diversity objectives. It is similar in some respects to the status quo, except the intensive management zone is preselected to include high productivity sites unencumbered by objectives for non-timber forest values.

- Wood supply priority is on log-potential spruce/fir while ensuring a sustainable supply of all other species groups.
- To better meet diversity values, protected area is increased four-fold to 16% of the forest and the conservation area is maintained at 30%.
- To provide long-term wood supply, 25% of the forest is designated as an intensive timber management zone. Candidate areas are chosen from mixedwood and other types of higher than average site quality. These sites are expected to have 33% greater yield and are designated for clearcutting so they can be planted.
- Stands included in the intensive zone are from the general forest but exclude those with more than 50% volume (individually) of tolerant hardwood, cedar, white pine, red spruce, or red pine. Such stands cannot be clearcut.
- The balance of the forest is managed with low-intensity prescriptions, which include non-clearcut harvesting in all eligible types, and permanent within-stand retention of 20% in all harvest areas.

Outcomes

- This alternative affects supply of log-potential spruce/fir differently in the short and long-terms. Increased protected area and low intensity harvest prescriptions on areas outside the intensive zone result in an a 7% short-term reduction relative to the status quo. Selecting higher productivity sites for the 25% of the forest which is planted results in a doubling of supply between the short and long-terms, and a 20% long-term gain over the status quo (Fig. 5-43).
- Supply of tolerant hardwood species is somewhat less than the status quo (Fig. 5-44), as many of the higher quality sites designated for planting support mixed stands that contain some component of tolerant hardwood species.
- By year 2062 plantations, unmanipulated forest, and unmanaged even-aged forest each make up approximately 23% of the total area (Fig. 5-45). This directly reflects the three land allocations that typify this alternative.
- The area planted shifts forest composition by increasing the spruce/fir type and decreasing the balsam fir type (Fig. 5-47).
- Old forest area drops to and remains at approximately 34%, with the vast majority of it in late-successional condition that develops in the protected areas (Fig. 5-46). The forest structure reflects the forest allocation under this alternative. Area older than 150 years is in the conservation forest. Much of the forest less than 51 years old is plantations in the intensive zone, and the balance of area is that managed for multiple objectives with low intensity treatments (Fig. 5-48).

Summary of Alternative 'G' Management Settings

Wood Supply	spruce/fir priority
Protected Area	16%
Conservation Forest Area	30%
Minimum Old Forest Area	25%
Maximum Plantation Area	25%
Harvest Treatments	emulate natural disturbance
Forest Composition	maintain under-represented types

Fig. 5-43 – Spruce/fir wood supply vs status quo ('G')

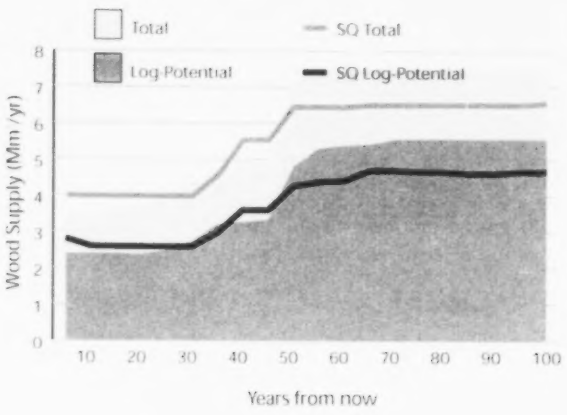


Fig. 5-44 – Log-potential wood supply ('G')

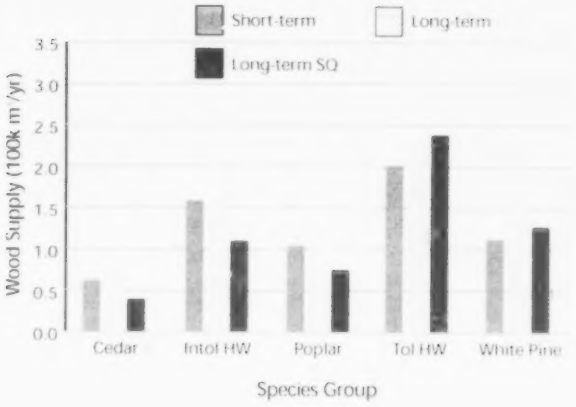


Fig. 5-45 – Area by management history at forecast year 50 ('G')

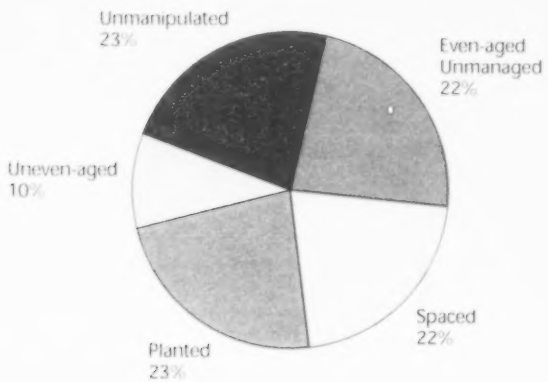


Fig. 5-46 – Old forest abundance over time ('G')

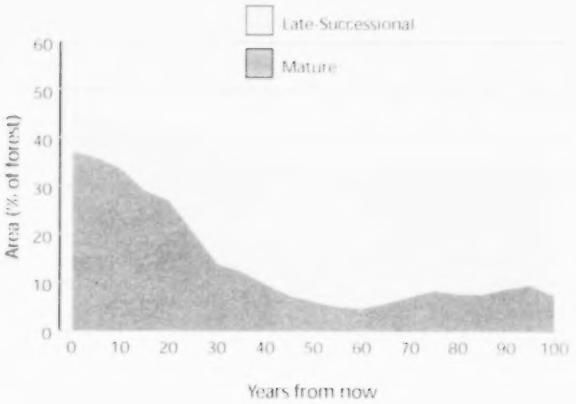


Fig. 5-47 – Forest stand type abundance ('G')

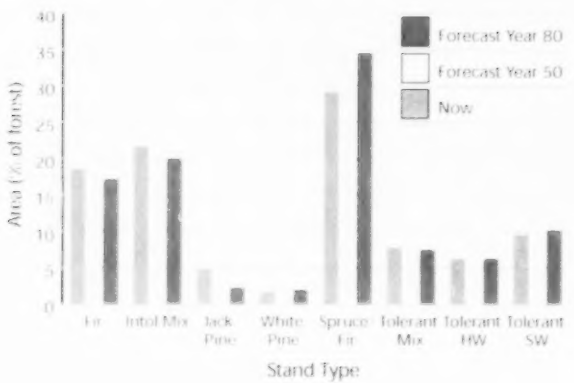
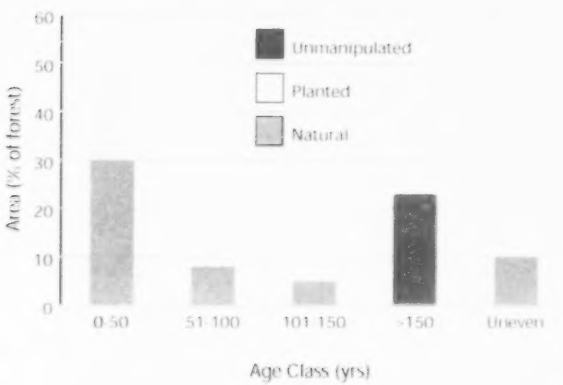


Fig. 5-48 – Age class structure at forecast year 100 ('G')



Comparison of Management Alternatives

As a complement to the summary of alternatives just presented, and to facilitate evaluation and comparison of alternatives, the following pages present outcomes ranked by magnitude on an indicator-by-indicator basis. For reference, a summary table of key outcomes across all eight management alternatives is presented at right (Table 5-2).

Table 5-2 – Summary of selected outcomes under eight forest management alternatives for New Brunswick Crown forest.

Indicator and Units	Alternative[1]							
	SQ	A	B	C	D	E	F	G
WOOD SUPPLY								
Spruce/fir Log-Potential[2] (million m³/yr)	2.7 4.2	1.7 2.2	1.7 2.3	2.3 3.5	2.5 5.1	2.8 5.3	2.6 4.4	2.5 4.8
Spruce/fir Total[2] (million m³/yr)	4.0 6.1	2.5 3.1	2.7 3.4	3.6 5.1	3.8 7.0	4.2 7.3	3.9 6.1	3.7 6.8
Other Softwood Log-Potential[2] (thousand m³/yr)								
Cedar	89 39	43 49	35 39	62 69	60 66	72 76	75 83	62 68
White Pine	133 128	67 136	51 112	95 141	118 189	130 200	131 212	113 173
Other Softwood Total[2] (thousand m³/yr)								
Cedar	146 58	70 70	55 55	99 99	96 96	113 113	119 119	98 98
White Pine	229 349	125 300	101 266	174 372	196 469	212 478	207 546	187 455
Hardwood Log-Potential[2] (thousand m³/yr)								
Sugar Maple and Yellow Birch	210 239	129 217	171 320	183 261	202 270	246 278	212 270	202 233
White Birch and Red Maple	234 110	113 127	128 170	158 158	158 158	179 179	171 171	159 159
Poplar	194 75	90 90	86 107	111 111	113 113	132 132	117 117	105 105
Hardwood Total[2] (thousand m³/yr)								
Sugar Maple and Yellow Birch	417 662	259 490	326 661	348 526	373 535	451 542	392 570	377 496
White Birch and Red Maple	848 603	453 499	503 585	615 627	608 608	677 677	650 669	608 616
Poplar	386 384	198 218	193 237	240 303	242 270	279 306	245 317	229 282
Wood Cost ($/m³ for years 1-25 in constant dollars)	43.3	44.5	44.9	44.6	45.1	43.7	45.7	44.8
Land Allocation (% of total forest area)[4]								
General forest	68	62	68	75	75	79	82	72
Protected natural area (PNA)	4	22	10	13	13	10	10	16
Conservation forest outside PNA	28	16	22	12	12	11	8	12
Forest Condition (% total forest area in 2062)								
Even-aged Planted[3]	22	5	13	19	37	37	23	23
Spaced	21	29	25	23	9	8	22	22
No silviculture treatment	27	25	20	21	23	27	21	22
Uneven-aged (created by harvest)	7	12	16	16	10	9	19	10
Unmanipulated	23	29	26	21	21	19	15	23
Old Forest (% of total forest area in 2062)	34	49	51	34	33	31	37	34
Forest Composition[3] (% of total forest area in 2092)								
Fir and Spruce/fir	54	53	41	47	49	52	51	52
Tolerant (pure and mixed)	21	26	37	30	25	23	26	24
Pine (combined)	4	4	6	5	6	6	4	4
Intolerant Mixed wood	21	17	16	18	20	19	19	20
Area clearcut (% of total area harvested over years 1-25)	81	49	52	50	66	72	45	53
Natural Disturbance-based Harvest (% of total area harvested over years 1-25)	23	100	58	63	40	34	100	73
Employment[5] (jobs/yr)	7600	3900	4000	6000	6500	7200	6700	6300
Value of Shipments[6] (billion $/yr)	1.44	0.72	0.72	1.07	1.14	1.30	1.19	1.11
Contribution to GDP[6] (billion $/yr)	0.80	0.40	0.40	0.59	0.64	0.72	0.66	0.62
Royalties[6] (million $/yr)	61	31	30	48	53	60	55	51

1. Highest values for each indicator are in bold; lowest values are underlined.
2. Left value in cell is average for years 1-25; right value is average for years 26-100. Higher precision in values is used for calculating percentages stated in text.
3. Stand types are described in more detail in main text.
4. Land allocation to conservation forest varies slightly from the options defined for some alternatives because of inoperable forest and non-spatial inventory compilation.
5. Plantation area changes through time in accordance with limits for each alternative; limits are not met until after year 50 for some alternatives.
6. Average for years 1-10 (in constant dollars).

Wood-based Business Opportunity

Wood Supply

Spruce/fir (Fig. 5-49)

- The short-term sustainable spruce/fir log-potential supply (years 1-25), which ranges across alternatives from 1.7 to 2.8 million m³/yr, is governed largely by the amount of conservation forest area, the degree of reliance on non-clearcut harvesting, and the level of permanent retention in harvested areas. All three are set at high levels in alternatives A and B; they thus result in low wood supply.

- Alternatives C and G include those same diversity-related objectives, but with targets for them set at lower levels, and include measures that mitigate the negative wood supply impacts. Thus, the sustainable harvest is only moderately below the status quo level (11% and 7%, respectively).

- Alternatives D and F produce approximately the same wood supply as the status quo in the short-term; they include a mix of measures whose net effect on spruce/fir wood supply is minimal. Under alternative D the protected area is increased to 13%, but overall conservation area is reduced to 25% of the forest. Under alternative F, low-intensity harvesting is implemented, but more area is available for harvest.

- Only alternative E results in a short-term supply higher than under the status quo, and it does so because conservation forest area is reduced from 30% to 20% of the forest. This immediately makes more area available for harvest which increases wood supply.

- Long-term spruce/fir supply (years 26-100) is primarily a function of the area and yields of plantations. The highest long-term supply, between 5.1 and 5.3 million m³/yr, is produced under alternatives D and E. Each allows 37% of the forest to be planted. Average plantation yields are highest under alternative G because high productivity sites are specifically sought out for planting, but plantation area is capped at 25%. Long-term supply levels under the other alternatives are generally proportional to the area in plantations.

White Pine (Fig. 5-50)

- Under most alternatives, sustainable short-term supply falls below that of the status quo, and long-term supply rises above it, by up to 50% under some alternatives. This results from the combined effect of the non-declining harvest, which reduces short-term supply to achieve long-term sustainability, and from harvest and silvicultural measures to promote white pine. Alternatives D, E, and F yield the highest future wood supply of white pine.

Cedar (Fig. 5-51)

- Short-term cedar supply is less than that of the status quo under all alternatives because each includes a non-declining harvest (unlike the status quo) which reduces short-term harvest to ensure long-term sustainability. This short-term harvest reduction and use of cedar-promoting harvest treatments result in modest long-term gains, which exceed that of the status quo under all alternatives except B.

Tolerant Hardwood (Fig. 5-53)

- Tolerant hardwood supplies are less variable in the short and long-terms across all alternatives because there exists a long-standing tolerant hardwood policy that prevents clearcutting and promotes tolerant hardwood in stands where it dominates. The only alternatives that improve on the status quo wood supply in the short-term are E and F where the supplies are higher because of reduced conservation forest. The long-term supply exceeds that of the status quo for all alternatives except A and G because of combined effect of objectives that promote tolerant hardwood.

Intolerant Hardwood and Poplar (Fig. 5-52 and 5-54)

- Intolerant hardwood and poplar supplies decline sharply over time under the status quo, but are sustained by the non-declining policy in other alternatives. The even supply levels that result are lower than the status quo supply in the short-term, but significantly exceed the status quo supply in the long-term. Alternative E provides the highest sustainable harvest levels of poplar and intolerant hardwood in the short and long-term.

Fig. 5-49 – Spruce/fir log-potential wood supply

Fig. 5-50 – White Pine log-potential wood supply

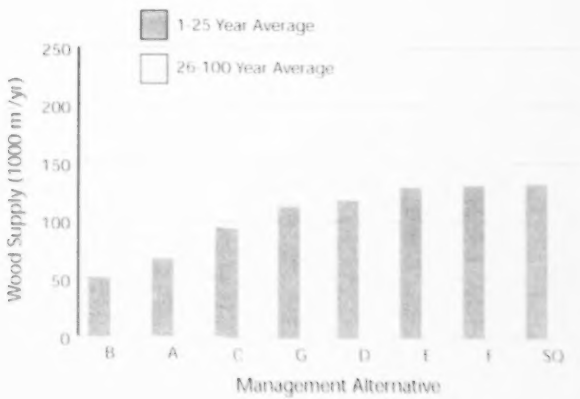


Fig. 5-51 – Eastern cedar log-potential wood supply

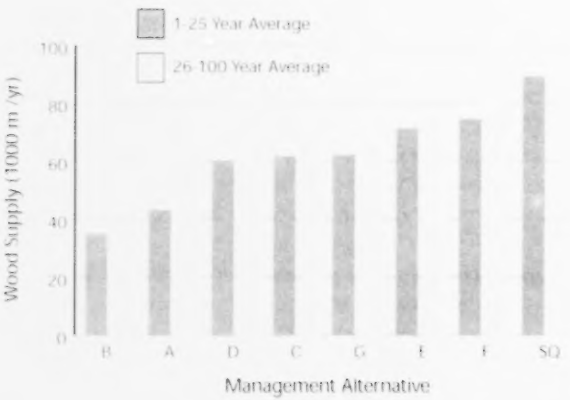


Fig. 5-52 – Poplar log-potential wood supply

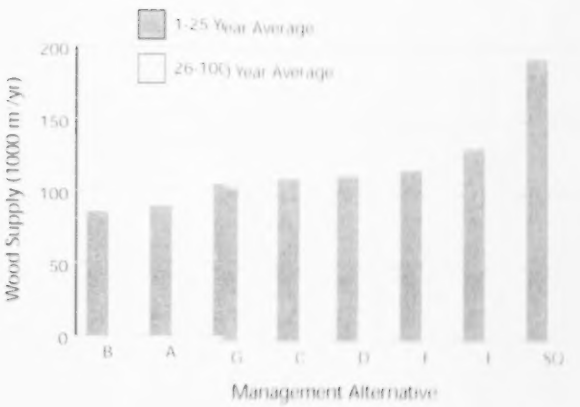


Fig. 5-53 – Tolerant hardwood log-potential wood supply

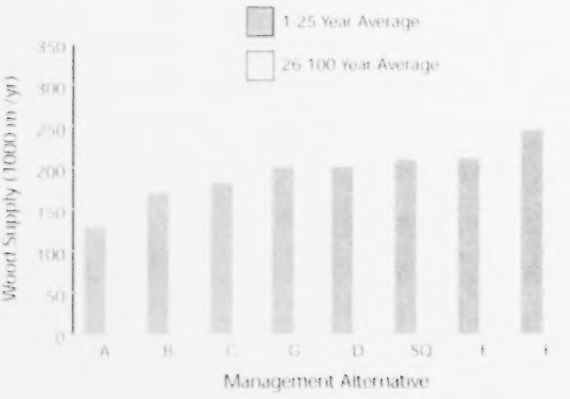


Fig. 5-54 – Intolerant hardwood log-potential wood supply

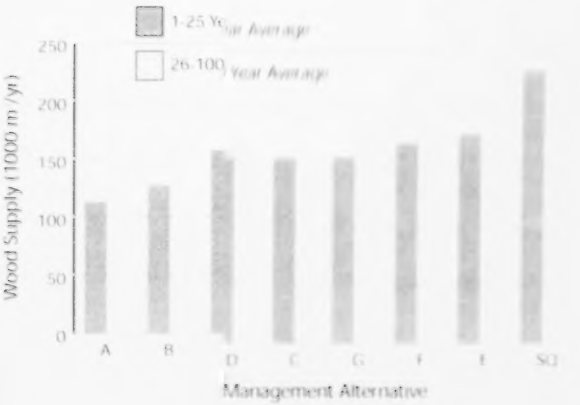


Fig. 5-55 – Minor species log-potential wood supply (average over forecast years 1-25)

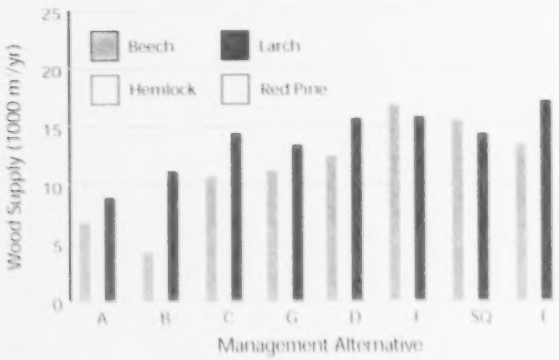


Fig. 5-56 – Wood cost (delivered and silviculture cost/m³ averaged over forecast years 1-25)

Minor Species (Fig. 5-55)

Red pine, hemlock, larch, and beech each make up less than 1% of the forest inventory by volume; however, they are important specialty species. The average log-potential wood supply for each species over the next 25 years roughly doubles across the range of alternatives. It is lowest under alternatives A and B because of their diversity objectives, and highest under alternatives E and F because they include reduced area in conservation forest.

Red pine supply increases noticeably under alternatives with high planting levels because the species is part of the current planting mix (approximately 2% of seedlings planted). Hemlock supply increases noticeably under alternative E because it is relatively abundant in the areas of conservation forest that are reallocated to general forest.

Wood Cost (Fig. 5-56)

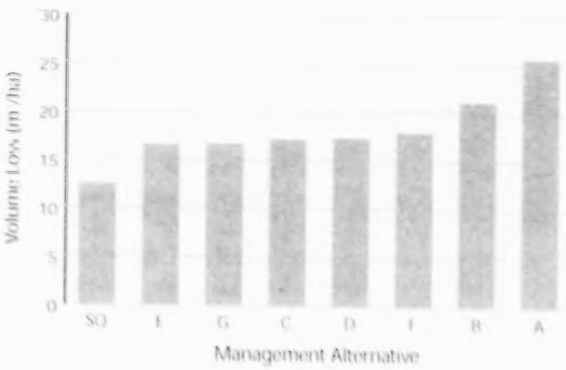
Wood cost is a combined function of harvest and silviculture costs. The former is governed largely by harvest prescription, with clearcutting being the least costly (Appendix 6). Silviculture cost is governed by the absolute amount of area planted and spaced. One or both factors cause average wood costs over the next 25 years to be higher than the status quo under all scenarios.

Wood costs are highest under alternative F (6% above status quo) because most of the harvesting is by higher cost, low intensity prescriptions and it maintains the current silviculture program. Alternative A also results in greater use of more costly non-clearcut prescriptions but the silviculture program is smaller and the associated costs are lower. Costs are lowest under the status quo and alternative E because those alternatives result in the greatest use of clearcut harvesting.

Potential Volume Loss to Budworm (Fig. 5-57)

Spruce budworm outbreaks have occurred in New Brunswick repeatedly in the past and are likely to recur. The magnitude of potential wood loss from such outbreaks, and the magnitude of protection effort required to prevent wood loss, are a function of the species composition and age of the forest. The higher and older the balsam fir content, and to a lesser extent the spruce content, the higher the potential loss to spruce budworm. The risk of volume loss from defoliation by budworm (measured as average m³/ha loss in the general forest and reported at year 50 of the forecasts) is greatest under alternatives that maintain or create these forest conditions (A and B) and least under those which reduce them (the status quo, E and G).

Fig. 5-57 – Potential spruce/fir volume losses from defoliation by spruce budworm (at forecast year 50)



Forest Diversity

Management History (at Forecast Year 50)

Unmanaged Even-aged (Fig. 5-58)

- This condition, resulting from natural regeneration in which no post-harvest silvicultural control is exercised, ranges from a low of 20% to a high of 27% of the total forest area. It is most abundant under alternatives in which the use of even-aged prescriptions (clearcut or shelterwood) is relatively high and where significant area is left unplanted or unspaced. This condition is most abundant under alternative A because of low absolute planting levels, and under E and the status quo because much of the silviculture budget is used for planting, which leaves much naturally regenerating area unspaced. This outcome is strongly affected by the silviculture budget, which is explored in a sensitivity analysis in Part 6. Under all alternatives except E and the status quo, roughly half of the area in this condition contains permanent retention patches to provide within-stand diversity.

Planted (Fig. 5-59)

- The percent forest area in plantations is a direct result of the planting levels employed in the alternative. Thus, after 50 years 37% of the forest is in plantations under alternatives D and E. This drops progressively as the plantation limit is reduced in other alternatives and approaches zero under A as existing plantations are harvested and not re-established. The planted area with internal structural diversity, resulting from permanent retention harvesting, is evident in five of the alternatives, and the proportion of area with retention will continue to increase over time as new ones are created in stands harvested by retention prescriptions.

Spaced (Fig. 5-60)

- Stands are spaced to control density and species composition and spaced area ranges from 8% to 29% of the forest across alternatives. Given a fixed silviculture budget, alternatives with relatively low levels of planting (A and B), result in the highest area in spacings. Those with high levels of planting (D and E) have the lowest area in spacings, as post-harvest stands are planted, rather than spaced.

Unmanipulated (Fig. 5-61)

- The area of unmanipulated forest varies two-fold across alternatives from 15% to 29% of the total forest area. The condition is defined by the absence of harvesting, so its abundance is directly related to the amount of conservation and protected area. Thus, it is highest and lowest under alternatives A and F, respectively.

Uneven-aged (Fig. 5-62)

- Area of stands harvested by uneven-aged prescriptions ranges across alternatives from 7% to 19%. The area is highest under alternative F which includes extensive application of low-intensity harvesting. Uneven-aged treatments are generally effective in favouring late-successional species, thus the area so-managed is highest under alternatives which attempt to restore late-successional species (A, B, and C). The area is lowest under the status quo and alternative E because their harvest treatment option requires non-clearcut harvesting on a relatively small proportion of the total forest.

Mature and Late-successional Forest (Fig. 5-63)

Mature and late-successional forest area is directly controlled by the old forest option of each alternative. Thus, it is highest (50% of the total forest at forecast year 50) under alternatives A and B, and drops progressively in response to the objective level set in each alternative. It is lowest under alternative E (31%) because of the low area in conservation forest. Under alternative F, the ratio of mature to late-successional forest differs from the others because the low-intensity harvesting it extensively employs maintains mature, but not late-successional conditions.

Fig. 5-58 – Unmanaged, even-aged area at forecast year 50

Fig. 5-59 – Plantation area at forecast year 50

Fig. 5-60 – Spaced area at forecast year 50

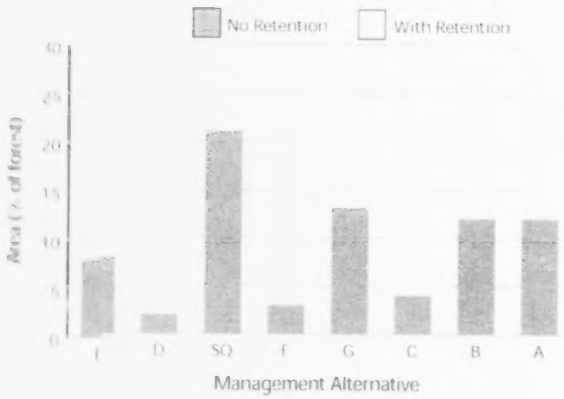


Fig. 5-61 – Unmanipulated area at forecast year 50

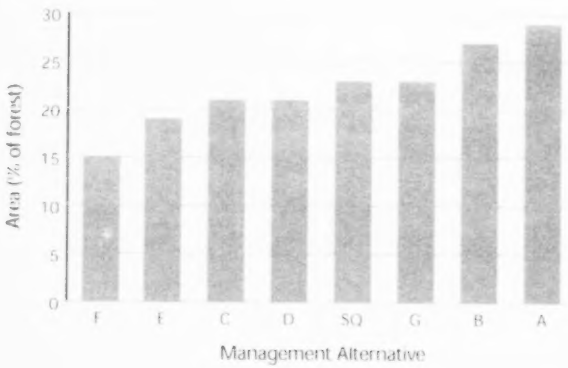


Fig. 5-62 – Uneven-aged management area at forecast year 50

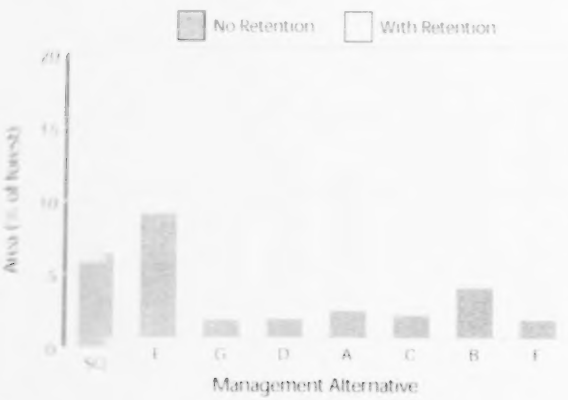
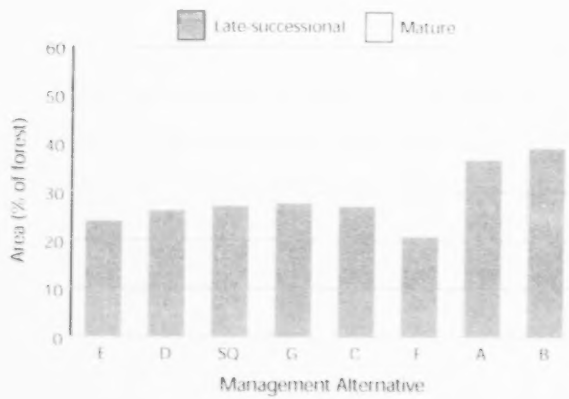


Fig. 5-63 – Mature and late-successional forest area at forecast year 50



Forest Composition by Stand Type (at Forecast Year 80)

Spruce/fir (Fig. 5-64)

- The spruce/fir stand type varies from 24% to 40% of the total forest area. Its abundance is governed largely by the area planted because spruce is the predominant species planted. Thus, it is highest under alternatives with the most area in plantations (D and E).

Balsam Fir (Fig. 5-65)

- The area of the balsam fir stand type varies considerably across alternatives, partly because there are no specific objectives for it in any alternatives, and partly because it can be controlled significantly by silvicultural choices. Its area is reduced as plantation area increases, which results in low balsam fir abundance (10%) under alternatives D and E and high abundance under A (26%).

Jack Pine (Fig. 5-66)

- The jack pine type is relatively scarce in all alternatives but is most abundant (almost 3% of the forest area) under those with the highest plantation area (D and E) because jack pine makes up 8% of the planting mix. It is least abundant (1.5%) under alternative A where no new planting occurs.

Pine (Fig. 5-67)

- The pine type (red and white pine) is also relatively low in abundance, but varies almost three-fold across alternatives. Its area is lowest under the status quo (1.5%), which includes no specific objectives for white pine. It is highest under alternative B (4.5%) which includes an objective to increase white pine abundance. Area of the pine type increases with area planted, because the silviculture regime includes planting white pine on sites to which it is ecologically suited.

Tolerant Softwood (Fig. 5-68)

- The degree to which alternatives favour late-successional species governs the abundance of this type, which includes red spruce, cedar, and hemlock. As a result, it is highest under alternative C (13% of the forest) and lowest under the status quo (<9%).

Tolerant Mixedwood (Fig. 5-69)

- The area of tolerant mixedwood varies from 4% to 14% and is highest under alternative B which has an objective to increase the area of this type to twice the level estimated in the 1940 benchmark. It is lowest under the status quo, because there are no specific objectives to maintain tolerant mixedwood.

Tolerant Hardwood (Fig. 5-70)

- The area of tolerant hardwood varies relatively little across most alternatives, partly because maintenance of this type is already part of the status quo alternative (under the tolerant hardwood policy). It does increase noticeably (to 11% of the forest) under alternative B which includes an objective to that effect. The degree to which its abundance can be changed is partly limited by the amount of area to which it is ecologically suited.

Intolerant Mixedwood (Fig. 5-71)

- The intolerant mixedwood type commonly regenerates following clearcutting. Thus, it is lowest (16%) under alternatives A and B which have the least area of clearcutting. The intolerant mixedwood type may be planted to softwood species, but this is limited by the non-declining wood supply policy for poplar and intolerant hardwood. Thus, intolerant mixedwood area is maintained even under alternatives E and D which have high planting levels.

Fig. 5-64 – Area of spruce-fir stand type at forecast year 80

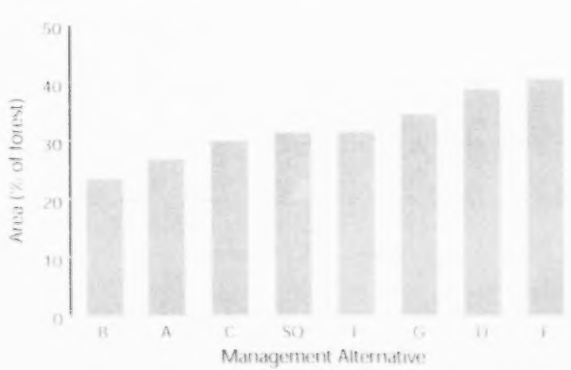


Fig. 5-65 – Area of balsam fir stand type at forecast year 80

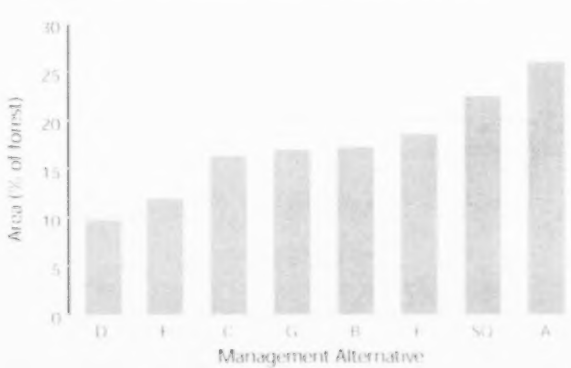


Fig. 5-66 – Area of jack pine stand type at forecast year 80

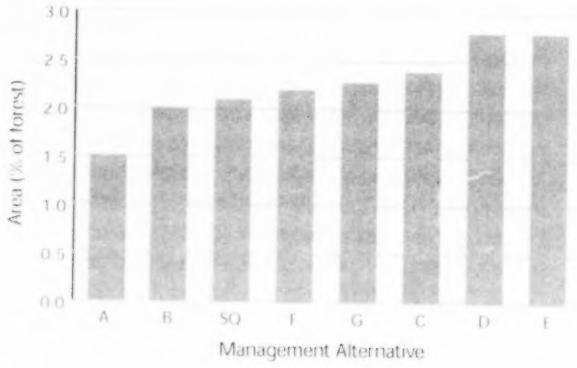


Fig. 5-67 – Area of pine stand type at forecast year 80

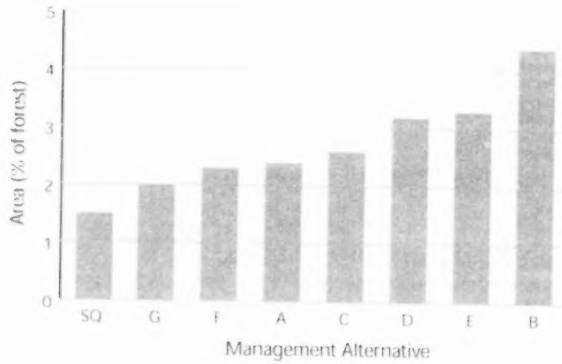


Fig. 5-68 – Area of tolerant softwood stand type at forecast year 80

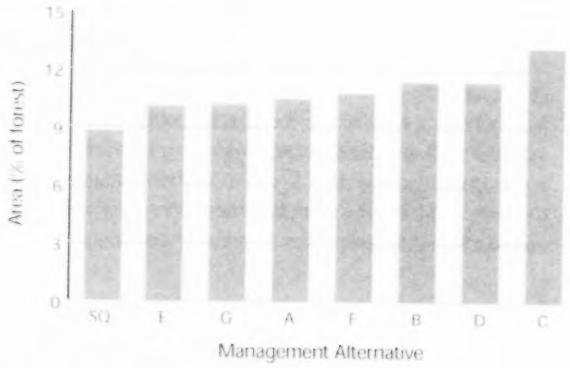


Fig. 5-69 – Area of tolerant mixedwood stand type at forecast year 80

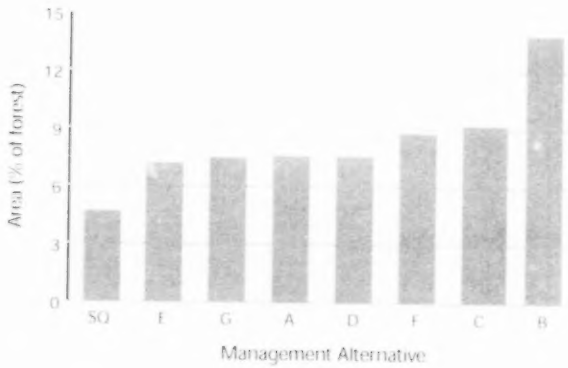


Fig. 5-70 – Area of pure tolerant hardwood stand type at forecast year 80

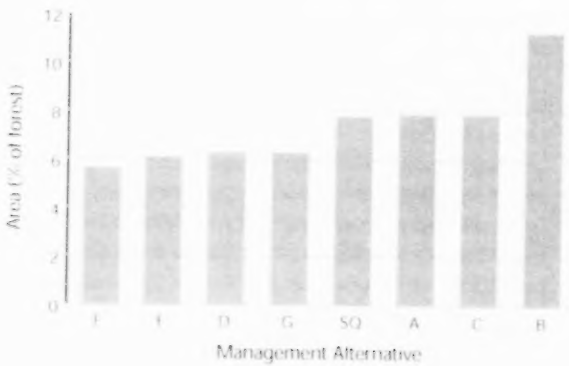


Fig. 5-71 – Area of intolerant mixedwood stand type at forecast year 80

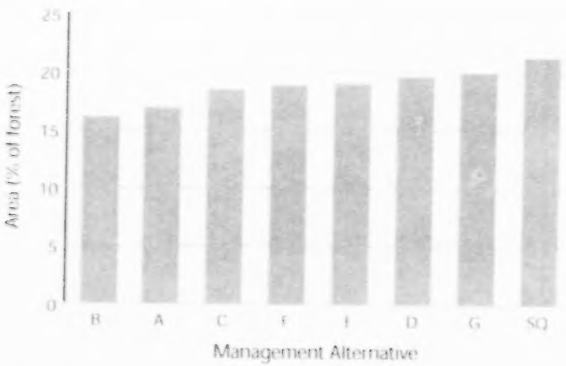
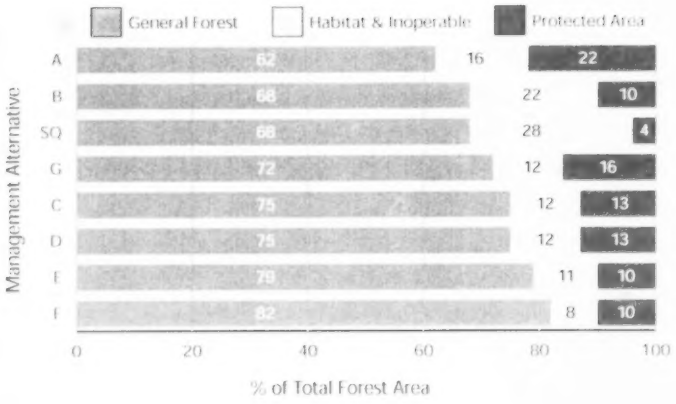


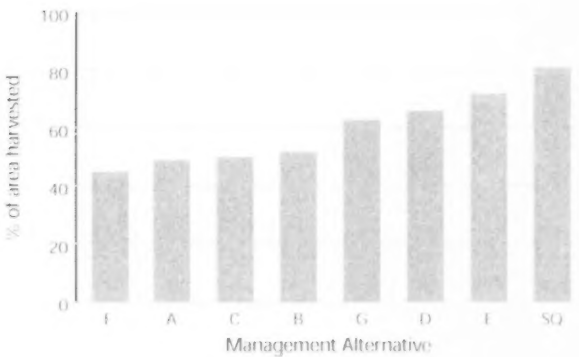
Fig. 5-72 – Land allocation



Land Allocation (Fig. 5-72)

The allocation of land into protected, habitat, and general forest areas, each with specific management objectives and treatment controls, is a fundamental decision that most directly influences forest diversity and wood supply outcomes. The area allocated to these zones reflects the options chosen in each management alternative. Protected area is highest (22% of the forest) and general forest area lowest (62%) under alternative A. General forest area is highest (82%) under alternative F (but only low intensity harvest treatments can be employed in it) and under E (79%). Land allocation objectives are not met exactly under some alternatives because of the methods used to define land allocation in the analysis.

Fig. 5-73 – Percent area harvested by clearcutting (average over forecast year 1-25)



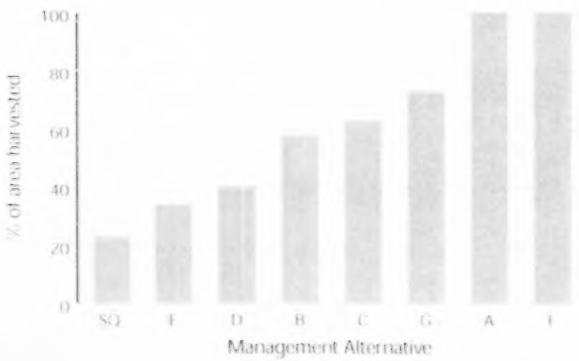
Area Clearcut (Fig. 5-73)

The proportion of area harvested by clearcutting as a percent of all area harvested reveals the relative degree to which clearcutting is employed in the management alternative. The percent varies two-fold across alternatives, from a high of 81% under the status quo, to a low of 45% under F. Alternatives that more heavily favour late-successional species employ less clearcutting (e.g. A, B, C), while those with less emphasis on such species employ clearcut harvesting the most (E and the status quo).

Harvest Relative to Natural Disturbance (Fig. 5-74)

The harvest prescription most likely to create stand conditions akin to those resulting from natural disturbance was defined for each type (e.g. for tolerant mixedwoods uneven-aged group selection creates conditions most like those resulting from gap disturbances to which the type is naturally prone). Area harvested according to those "natural disturbance-based" prescriptions as a percent of total area harvested reflects the degree to which naturally occurring species and structures are likely to be maintained. That percentage is highest (100%) under alternatives A and F, which have the objective to emulate natural disturbance. It ranges from 60% to 75% under alternatives B, C, and G which have the objective to promote late-successional species. The partial harvesting this requires creates conditions similar to those caused by natural gap disturbances. It is lowest, less than 40%, under the status quo and alternatives E and D. These alternatives rely heavily on harvest prescriptions which create stand conditions unlike those resulting from natural disturbance.

Fig. 5-74 – Percent area harvested in accordance with natural disturbance tendency (average over forecast years 1-25)



Stored Carbon (Fig. 5-75)

Although not a specific objective in any of the alternatives, the carbon stored in the forest is an important outcome given its role in mitigating climate change (and also its potential financial value). Stored carbon is closely related to standing inventory and the alternatives that have the highest inventory store the most carbon (Appendix 9). The levels change over time, but using years 20 and 80 as reference points, forest carbon under all alternatives exceeds that of the status quo. Carbon is high under alternatives A and B because they retain much unharvested old forest which contains a high standing inventory; it is high in the long-term under alternatives D and E because both result in a high inventory in the large area of plantations.

It is important to note that carbon is contained in the wood volume harvested, and that carbon stored in the forest will increase by the amount of available wood supply left unharvested. Thus, the larger the future wood supply, the larger the mass of carbon that could be stored in the forest should carbon storage be deemed in the future more important than wood supply. In this case, the greatest opportunity to store carbon results under alternatives D and E. Alternatively, carbon can be stored in the form of durable forest products. To the extent such products are produced from harvested volume, alternatives D and E represent the highest potential carbon storage because of their high wood supply levels.

Snags (Fig. 5-76)

Ecologically, snags are a legacy component in stands that provide important within-stand structural diversity. At forecast year 80, the percent of the forest area containing at least 6 large (>30 cm diameter) snags per hectare varies two-fold across scenarios. Snag abundance is high under alternatives that retain much unharvested or old forest; thus, it is highest under alternatives A and B, and lowest under E and F.

Area Planted to Non-Native Species (Fig. 5-77)

Norway spruce makes up 5% of the current planting mix, and the area of Norway spruce-dominated plantations is directly proportional to the limit on plantation area under each alternative. Thus, at year 50 Norway spruce plantation area is highest (2% of the forest) under alternatives D and E, and lowest (near zero) under A.

Fig. 5-75 – Tonnes of carbon stored in forest at forecast years 20 and 80

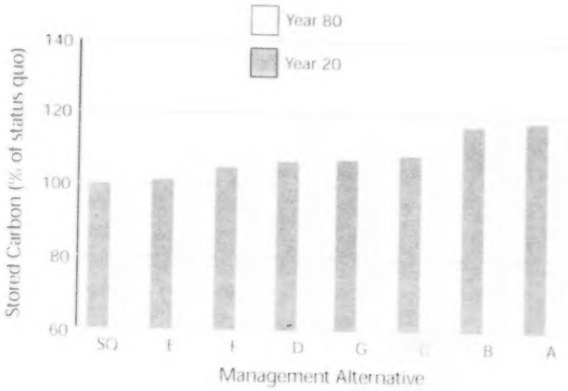


Fig. 5-76 – Forest area (%) with >6 snags/ha (30 cm+ diameter) at forecast year 80

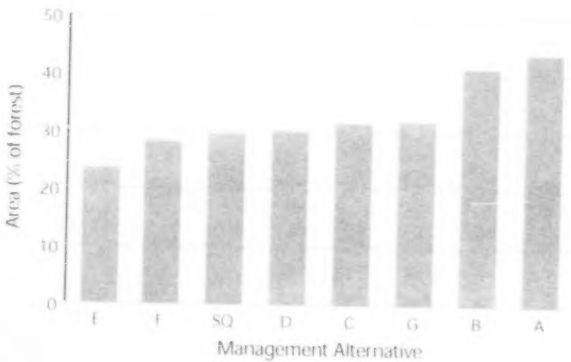
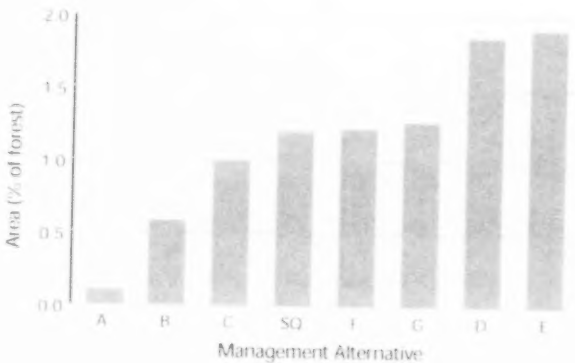


Fig. 5-77 – Area of Norway spruce plantations at forecast year 50



Riparian Buffers

Riparian buffers are maintained in their present state under the status quo and alternatives A, B, and G. They are reduced to the 30m minimum requirement of existing DNR standards under alternatives C, D, E, and F. This should maintain water quality objectives but will reduce the width of some buffers established for aesthetic value. The 20% conservation forest area required under alternative E can be attained in many ways, including ones that maintain a 30 m minimum reparian buffer width, as was done in this analysis. DNR would have to determine what makeup of conditions best meets conservation objectives under alternative E before any definitive statement could be made about riparian buffers.

Wildlife Habitats (Figs. 5-78 to 5-83)

Shown here is the area at year 80 meeting stand structure criteria defined by the DNR Fish and Wildlife Branch for six habitat types. Spatial criteria (e.g. minimum patch size) are not considered.

With the exception of alternative F, the amount of area in each habitat type is directly related to the amount of area in the conservation forest. Accordingly, habitat levels are generally highest under alternatives A and B, and lowest under E.

The exception is alternative F which has the least amount of conservation forest, but which requires low-intensity harvest prescriptions to be employed extensively in the general forest. Where those prescriptions maintain stand conditions that meet the structural habitat criteria, alternative F produces high habitat levels (e.g. Old Forest and Old Tolerant Hardwood Habitats). In some stand types, the low-intensity harvests, and follow up spacing in regeneration gaps, shift the composition from mixedwood to hardwood; thus alternative F results in a high Old Hardwood Habitat level and a lower Old Mixedwood one.

Where low-intensity harvesting does not retain the required structures, habitat area is lower under alternative F (e.g. Old Pine and Old Spruce/fir Habitats). Leaving such types unharvested appears to be the best way of maintaining habitat-suitable conditions in these types.

Fig. 5-78 – Old Forest Habitat area at forecast year 80

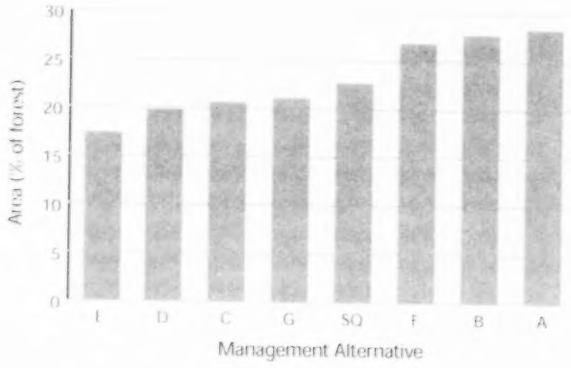


Fig. 5-79 – Old Hardwood Habitat area at forecast year 80

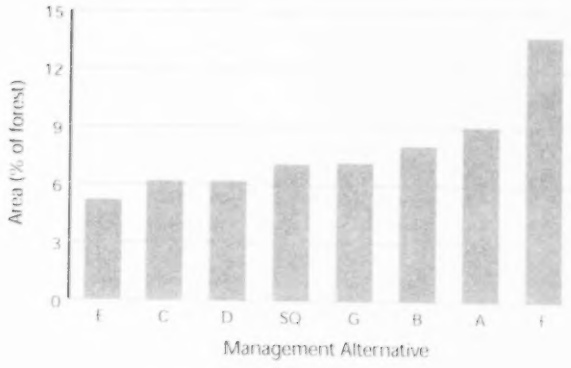


Fig. 5-80 – Old Mixedwood Habitat area at forecast year 80

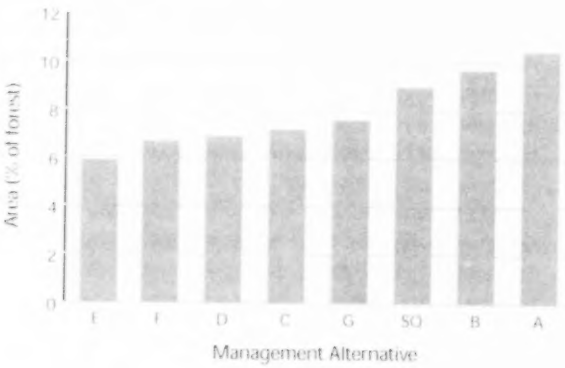


Fig. 5-81 – Old Pine Habitat area at forecast year 80

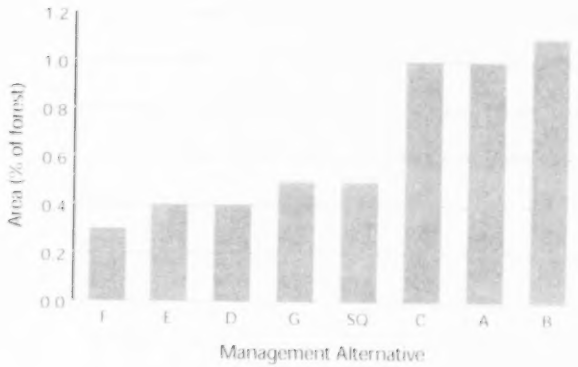


Fig. 5-82 – Old Spruce-fir Habitat area at forecast year 80

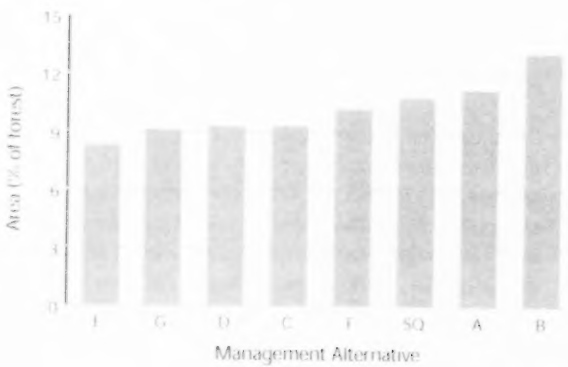
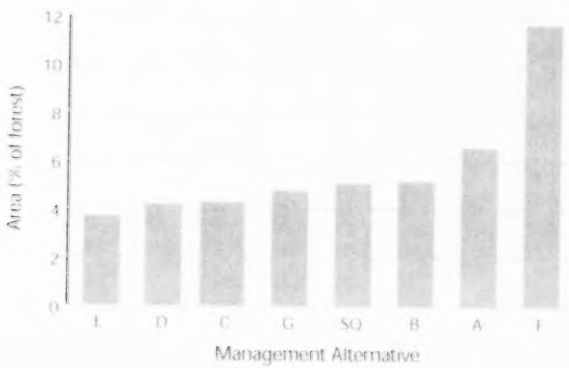


Fig. 5-83 – Old Tolerant Hardwood Habitat area at forecast year 80



Socio-Economics Related to Wood Supply

It is important to avoid comparing the indicator values presented here to others which are reported based on total provincial activity. This analysis addresses only Crown land, and the indicator values represent only a part (roughly half) of the provincial level socio-economic impacts of wood harvesting and processing. A full account of forestry activities, wood supply, and wood processing would require inclusion of the 50% of the total forest in private ownership and volume of imported wood.

All of the following indicators were calculated assuming full harvest and primary processing of the available Crown wood supply. As such, reported values represent maximum potential levels.

Employment (Fig. 5-84)

Average direct employment levels roughly double between alternative A (3900 jobs) and the status quo (7600 jobs) and generally increase in proportion to volume of wood supply. Direct employment includes jobs involved in silviculture (planting and spacing), logging, and primary manufacturing of wood products (Appendix 10).

Seasonal silviculture work makes up between 13% and 19% of total employment, and varies by the absolute amount of area planted and spaced, with spacing creating more employment per hectare treated.

Downstream processing of wood products has not been factored into employment estimates because the nature of that processing is unknown given recent changes in the industry. Further, within the limits posed by raw material quantity and quality, such processing is the subject of industrial strategy, not forest management strategy.

Royalty Revenues (Fig. 5-85)

Based on 2007 Crown royalty rates (Appendix 10), the status quo produces the highest short-term royalty revenue ($61 million/yr). Although E generates more spruce/fir volume, the status quo produces more hardwood in the short-term. Royalties under other scenarios vary in relation to the volume of spruce/fir log-potential, as this makes up the vast majority of harvest volume.

Fig. 5-84 – Annual direct employment averaged over forecast years 1-10

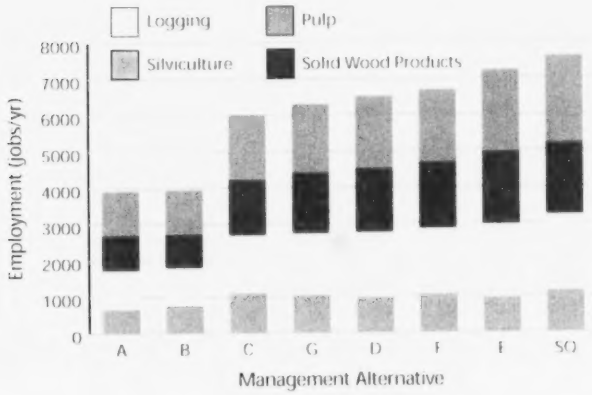
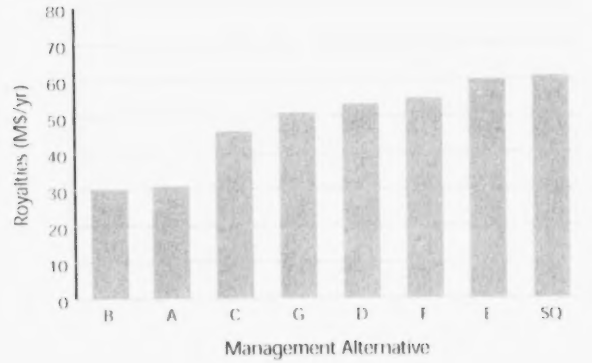


Fig. 5-85 – Annual timber royalties (M$ constant undiscounted) averaged over forecast years 1-10



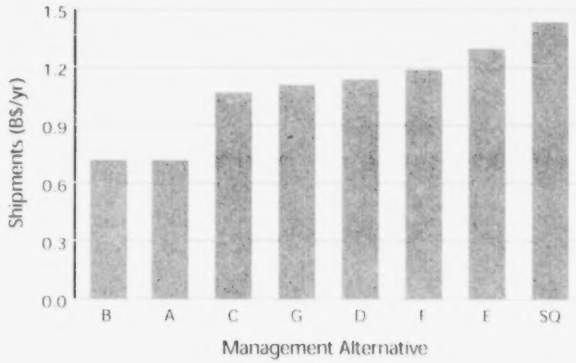
Value of Shipments (Fig. 5-86)

Value of shipments is based simply on the unit selling price of pulp, lumber, and veneer and the production of each made possible by the wood supply available under each alternative (Appendix 10).

The short-term averages (next 10 years) vary two-fold from a low of $0.7 billion/yr (constant dollars) under alternatives A and B to a high of $1.4 billion/yr under the status quo. These values are obviously subject to change as prices change, but provide a short-term relative measure based on today's prices.

The largest determinant of value is the total volume of wood harvested. Because all alternatives, except the status quo, employ non-declining harvests of log-potential volume for all species groups, there is limited variation in the species composition and quality composition of the overall wood supply generated under the alternatives. The largest wood supply variation is in absolute volume, which in the short-term, is proportionally similar in composition by species and quality.

Fig. 5-86 – Annual value of shipments (B$ constant undiscounted) averaged over forecast years 1-10

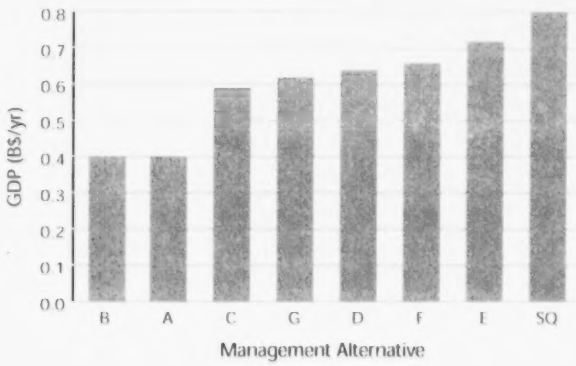


GDP (Fig. 5-87)

Gross domestic product (GDP) is derived from the value of shipments using economic multipliers calculated by Statistics Canada. Different multipliers are applied to the solid wood and pulp sectors. With downstream processing unknown, the GDP estimates here relate only to the point of pulp, lumber, and veneer production.

Being derived from value of shipments, and given relatively similar species and quality mix in the short-term between alternatives, the pattern of GDP outcomes follows that of shipment value. The alternatives rank in the same order and the values double from the lowest ($0.4 billion/yr under alternatives A and B) to the highest ($0.8 billion/yr under the status quo).

Fig. 5-87 – Annual contribution to gross domestic product (B$ constant undiscounted) averaged over forecast years 1-10



Part 6
Sensitivity Analysis

Report of the New Brunswick Task Force
on Forest Diversity and Wood Supply

The forecast outcomes for each management alternative are a combined function of the management options that make up the alternative and the expected development patterns of stands that make up the forest. Change either, and the forecast outcomes change.

The previous two sections revealed the sensitivity of outcomes to changes in the options that define alternatives; however, there are other outcome-controlling factors in these alternatives that, held constant to this point, warrant consideration in evaluating the management alternatives.

To provide a more complete picture of management alternatives, sensitivity analyses have been conducted on six of these factors. Four were chosen because they represent important management decisions; and two were chosen because they represent important sources of uncertainty about future stand development.

Harvest Timing

An important management decision relates to the time at which available volume is harvested. Harvesting can be conducted as soon as stands reach harvestable form, or it can be delayed to allow stands to grow and produce more volume in the future. In general, preference for early timing will increase short-term supply at the expense of long-term supply, and preference for later timing will have reverse effect.

A discount rate was used to express timing preference, and this was set at 4% for all alternatives (except the status quo). This rate was felt by the Task Force to strike a reasonable balance between early and late harvest timing preference.

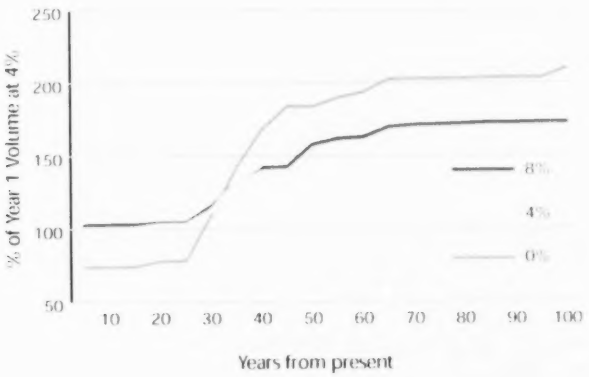
Recognizing that there may be an interest in a different timing preference, the sensitivity of harvest outcomes was tested for alternative D using two other discount rates:

- an 8% rate, which provides maximum sustainable harvest in the short-term irrespective of impacts on potential harvest increase in the future;
- a 0% rate, which introduces no timing preference, and produces maximum volume over the entire time horizon, irrespective of when that harvest volume is realized.

Using the total log-potential harvest under a 4% discount rate as a point of reference, no timing preference (0%), reduces the short-term and increases the long-term harvest, and produces 14% more volume accumulated over the 100 year time horizon (Fig. 6-1). Preference for early harvest (8% rate) increases the short-term harvest marginally, decreases the long-term harvest, and produces 8% less volume accumulated over the 100 year time horizon.

The increased overall supply with no timing preference results from harvesting being delayed until stands reach their point of highest productivity. Early timing preference results in some stands being harvested prior to that point, which leads to reduced overall harvest volume.

Fig. 6-1 – Sensitivity of log-potential supply to timing preference



Log-potential Specifications

Harvest objectives for all species groups were based on dimension classes deemed to be of log-potential quality (as defined in Appendix 5). What constitutes log-potential volume, and therefore, what size classes of timber should be the basis for harvest objectives, is a management choice.

In all analyses presented so far, the definition of spruce/fir "log-potential" volume included material of studwood size (12cm top x 2.55m length) and all larger size classes. To evaluate the impact of this decision, spruce/fir log-potential was defined in two additional ways:

- all volume to a minimum specification of 18cm top diameter and 2.55m length (termed short logs here);
- all volume to a minimum specification of 18cm top diameter and 5.05m length (termed long logs here).

Two analyses were then performed using alternative D, one maximizing the non-declining harvest of short logs, and one maximizing the non-declining harvest of long logs. In each case, wood supply was broken down by four categories, pulpwood, studwood, short logs, and long logs.

The choice of size classes to employ in the wood supply objective directly influences the age at which stands are harvested; all else equal, the larger the target size class, the older the stand at time of harvest. Additional time allows trees to attain larger dimensions.

This effect on extending harvest timing results in the short and long log objectives producing less total volume, but more volume in the long-term of large-dimension classes (Fig. 6-2).

When the wood supply objective is based on short logs, the 25-year and 100-year average total spruce/fir harvests drop by 20% and 4%, respectively, relative to the case in which studwood is classed as log-potential (Fig. 6-2). When the wood supply objective is based on long logs, resulting in still older harvest ages, the 25-year and 100-year average total spruce/fir harvests are reduced further, by 28% and 8%, respectively.

The short and long log harvest objectives increase the overall supply of short and long logs. The 100-year average short log supply increases 15% and the long log supply increases 27% above that available when studwood is included in the wood supply objective (Fig. 6-3). An additional impact of the extended harvest ages that result under the short and long log wood supply objectives is an increase in the abundance of old forest by 5-10% in the long-term.

Fig. 6-2 – Short-term average (years 1-25) spruce/fir harvest by product class

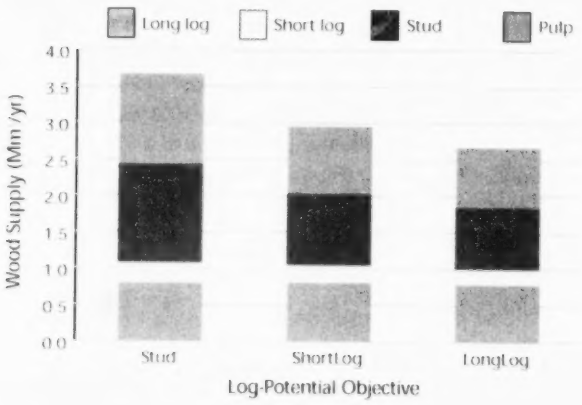


Fig. 6-3 – Long-term (100 year) average spruce/fir harvest by product class

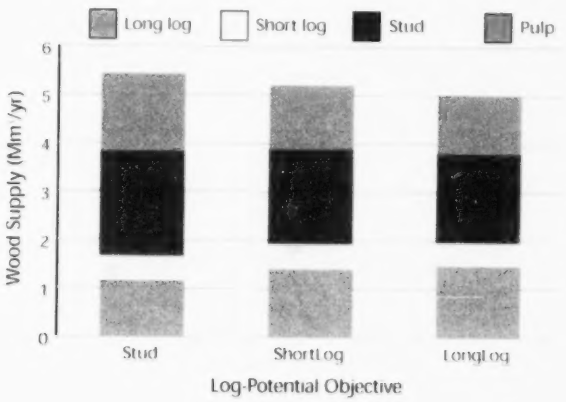


Fig. 6-4 – Area in spaced and unmanaged even-aged stands at forecast year 50 for D and E under $24 M/yr and $30 M/yr budget levels

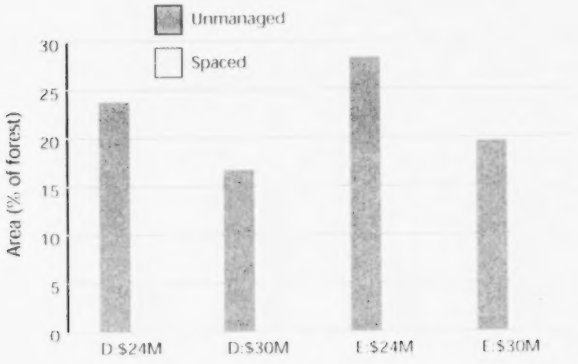


Fig. 6-5 – All species log-potential wood supply under $24 M/yr and $30 M/yr budget levels (Alternative E)

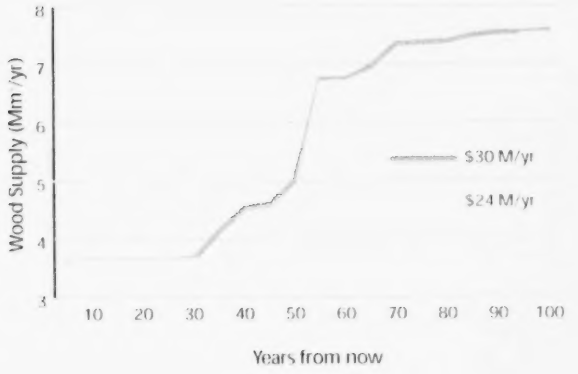
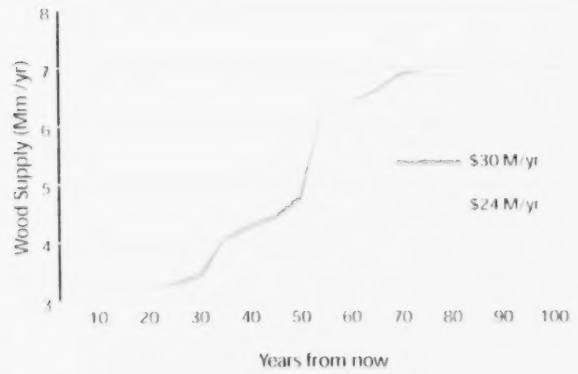


Fig. 6-6 – All species log-potential wood supply under $24 M/yr and $30 M/yr budget levels (Alternative D)



Silviculture Budget

The annual investment in silviculture activities is another important management decision affecting both wood supply and future forest conditions. Analyses of all alternatives to this point used the current budget, approximately $24.5 million/year. This could be allocated to planting and spacing in various relative amounts depending on the management options defined in each alternative. In some of the alternatives (e.g. A and B) the full $24.5 million annual budget was not required to achieve the objectives sought. However, in others, especially those with higher planting levels (e.g. D and E) the $24.5 million was fully utilized and, thus, constrained realization of wood supply objectives.

To test the effect of relaxing this constraint, the silviculture investment was increased by 25% to $30 million/year for alternatives D and E.

Because of the greater yield produced in plantations, the $24.5 million/yr budget was first allocated to planting and the maximum allowable plantation area for these alternatives (37% of the forest) was achieved at that budget level. Thus, the additional $5.5 million/yr investment under the $30 million/yr level was allocated entirely to spacing areas of natural regeneration. This significantly changes the amount of spaced and unmanaged even-aged stands in the forest. At year 50 of the forecast the spaced area under the $30 million/yr budget doubles for both alternatives to 15% of the forest from its 8% level under the $24.5 million/yr budget (Fig. 6-4). There is an equivalent reduction in the area of unmanaged stands, which are where the increased spacing occurs.

The benefit of the increased investment is primarily in terms of an earlier opportunity to increase harvest levels, moreso than an absolute yield gain. The increased area of spacing provides earlier increases in wood supply because trees in spaced stands grow more rapidly, causing spaced stands to be suitable for harvest sooner than unspaced ones. This translates into a 10% wood supply increase under alternative E (Fig 6-5) and a 5% increase under alternative D (Fig 6-6) beginning in 30 years.

An alternative approach is to allocate the additional silviculture funding to increase plantation area above the 37% cap. Removing this limit from alternative E, with a $30 M per year silviculture budget, has no effect on spruce/fir supply in the short-term, but increases it in the long-term (average after year 30) by roughly 5%. Plantation area under this option increases to 40% of the total forest area after 50 years.

Permanent Retention in Harvest Areas

Permanent retention in harvest areas is being increasingly viewed by forest ecologists as important for providing stand-level biological legacies, structural diversity, and habitat for disturbance-sensitive flora and fauna.[76] Accordingly, several of the management alternatives include retention in the harvest treatment options.

There may be interest among some parties in raising or lowering the retention levels in harvested areas. Raising them may be desired to realize greater ecological benefits. Lowering them may be desired to reduce wood supply impact in recognition of the presence of unharvested area elsewhere on the landscape.

In either case, the wood supply impacts can be readily approximated. They will be generally proportional to the chosen retention level. For example, reducing retention from 5% to zero in alternative C will result in a 5% increase in wood supply of all species. Raising it from 5 to 10% will reduce wood supply of all species by 5%. The actual impact will depend on how representative residual patches are of the parent stand in terms of volume and tree size.

Plantation Yields

The area and yield of plantations greatly influence outcomes under all alternatives. While much yield analysis of plantations has been conducted in the province, there remain several sources of uncertainty about yields that will actually materialize; no operationally established plantations have reached maturity; cultural practises continue to change and improve; policies that determine planting sites can and will change over time.

Given the importance of plantations and the uncertainty about yield, sensitivity analyses were conducted to examine the impact of plantation yield on outcomes. Results presented to this point for all alternatives (except G) were based on an average yield of 6m /ha/yr for all post-2007 plantations.

To test the effect of different yield assumptions, forest development was forecast with average yields decreased to 5m³/ha/yr and increased to 8m³/ha/yr. This test was conducted on alternative E because it includes a higher level of planting. Results for the other alternatives will follow the same relative pattern, but differ in absolute terms based on the planting levels employed.

Change in yield of post-2007 plantations has little short-term effect on spruce/fir log-potential wood supply because the plantations will not reach harvestable form for some time (30 years for commercial thinning and 50 years for clearcutting).

However, as they do become harvestable in the future, their yield directly influences available wood supply. At 8m³/ha/yr, the future wood supply almost triples from that available in the near-term, rising from 2.8 to 7.9 million m³/yr (Fig. 6-7). At a plantation yield of 5m³/ha/yr, the future harvest still increases, but by a lesser amount; it increases 85% from 2.8 to over 5.0 million m³/yr.

Compared to the currently assumed yields of 6m³/ha/yr, actual yields of 8m³/ha/yr would provide 15% more harvest volume over the next 100 years. Similarly, actual yields of 5m³/ha/yr would result in 9% less volume over that time frame.

Volume Loss in Non-clearcut Harvesting

An important consideration in use of non-clearcut harvesting is the potential for volume loss of residual merchantable trees due to wind damage. Partial removal of the canopy can result in structural instability of the stand, leading to trees being uprooted or broken off. Spruce and balsam fir growing on shallow soils tend to be most vulnerable to this occurrence.

Because the eight management alternatives presented in this report vary considerably in the amount of non-clearcut harvesting employed, the impact of such windthrow losses could be a serious wood supply concern under some alternatives; but no windthrow losses attributable to partial harvest were assumed in the analysis presented in Part 5.

To test the sensitivity of outcomes to possible volume loss from windthrow in residual stands following non-clearcut harvesting, forest development was forecast under each alternative assuming stand level losses of 15%, 30%, and

Fig. 6-7 – Spruce/fir log-potential wood supply under three plantation yield levels

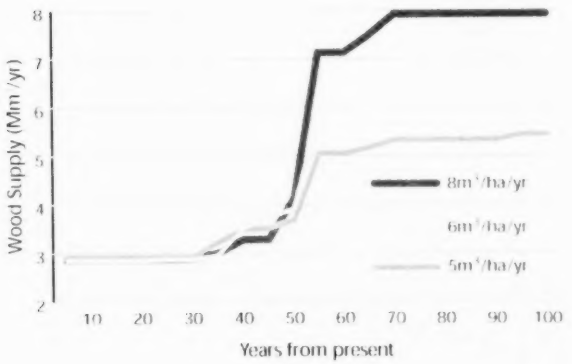
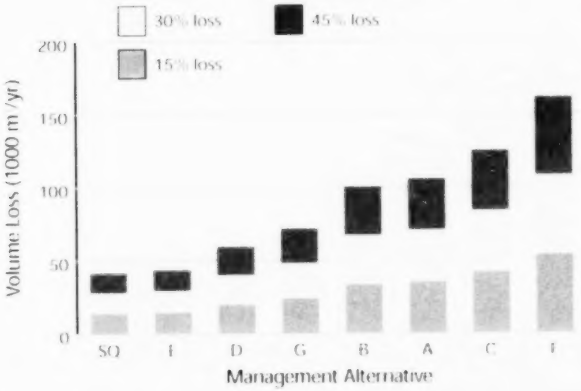


Fig. 6-8 – Potential spruce/fir wood supply reduction under three levels of volume loss to windthrow after non-clearcut harvesting



45% of the residual spruce/fir volume. In these forecasts, volume harvested by non-clearcut treatments was adjusted to reflect these three levels of loss.

The spruce/fir volume lost to windthrow increases directly with the amount of area harvested by non-clearcut treatments and is therefore highest under alternatives F and C and lowest under the status quo and alternative E (Fig. 6-8).

Expressed as an average reduction to the annual spruce/fir wood supply, the loss could run as high as 160,000 m^3/yr under alternative F and C if 45% of the residual spruce/fir volume was lost to windthrow. The absolute losses across all alternatives drop in direct proportion to the percent loss at the stand level; for example, under alternative F the wood supply loss is 100,000 m^3/yr with 30% windthrow of residual volume and 50,000 m^3/yr with 15%.

It is worth noting that realized losses could be reduced through aggressive salvage harvesting, although this would likely incur higher costs.

Interpolation of Other Alternatives

The matter of interpolating to make inferences about alternatives which differ from the eight presented here was discussed at the start of Part 5. However, such interpolation greatly expands the utility of the analyses presented here, and thus warrants re-iteration.

The number of unique management alternatives that can be defined by combinations of options across the seven cornerstone issues is enormous (exceeding 20 thousand), and impossible to fully present here. But while the Task Force deemed the eight presented alternatives to be of particular interest, they need not restrict consideration of other alternatives.

Provided other alternatives can be defined in terms of the seven cornerstone issues, their probable outcomes can be inferred by reference to the appropriate issue in Part 4 and assessing the impacts presented there for the options of particular interest.

For example, if one is interested in alternative C, but with greater protected area, the nature and direction of change in outcomes can be inferred from the protected areas section of Part 4.

Part 7
Final Considerations

Report of the New Brunswick Task Force
on Forest Diversity and Wood Supply

While the Task Force has attempted to be complete and comprehensive in its analysis of management alternatives, there are several matters not addressed here that warrant careful thought and consideration in the decision about how best to manage the forest. To ensure such matters are not overlooked, they are briefly brought to attention here.

Management Planning for Implementation

The analyses presented were designed to provide an overall view of management alternatives for the full 3 million ha of public forest. They differ in several ways from the detailed type of analysis normally conducted in design of implementation plans for a specific forest license: they do not include spatial allocation of treatments across the landscape; no volume net-downs are made for operational factors; and all licenses are combined into one landbase. The impacts of implementing any alternative may vary by license because of between-license differences in forest condition.

As a result, the absolute wood supply outcomes cannot be compared to allocation volumes or to wood supply results from the current forest management plans for the licenses. For these same reasons, should any of the eight alternatives become the basis for implementation at the license level, the outcomes will differ from those presented here in absolute magnitude. Regardless, the alternatives as presented here should provide an accurate view of relative impacts which should remain generally valid upon introduction of the more detailed steps in the planning process required for implementation.

Wood Supply Utilization

Recent significant changes in the forest industry have made unclear the degree to which available wood supplies will be actually used by industry, and if used, by what type of industry. The economic indicators presented here assume full utilization of the available wood supply. To the extent full utilization is not made of the wood supply, many of those indicator levels will change.

Similarly, the economic indicators assume current utilization standards and merchandizing practises (e.g. hardwood sawlog specifications). To the extent merchandizing practises change the proportion of volume suited to various forms of manufacturing, so too will the value of shipments and related economic measures.

Product Prices

The monetary economic indicators were based on product prices today and as forecasted for the next 10 years (Appendix 10). Market prices are volatile and subject to change due to market forces. Any deviation of actual prices from those employed in this analysis will translate directly into change in the economic performance of each alternative.

Forest Ownership

As mandated, the Task Force examined management alternatives only for the public forest, which represents half of the total forest in the province. All of the reported results relate only to that half. When evaluating management alternatives, it is important to factor in private woodlots and industrial ownerships (which make up 30% and 20% of the forest, respectively). The overall health and diversity of New Brunswick's forest and forest economy will be governed by the management choices made across all three types of ownership.

Low Quality Fibre

By design, the alternatives examined here focused on production of higher quality log-potential volume of all species. However, harvesting this higher quality material will unavoidably generate low quality material (e.g. tops and small, deformed or defective trees, or sections of trees) that does not meet quality specifications.

Although the proportion of the harvest in low quality material will decrease through time as silviculturally treated stands become available for harvest, and can be reduced with improved merchandising, the proportions will be significant in the near term. The volume of low quality material harvested will vary by species and utilization specifications: 25 to 35% for spruce/fir, and 50% to 80% for other species. The importance of a viable economic market for this low quality material should be recognized when evaluating management alternatives. In some situations, biomass for energy generation may offer potential where markets for better quality products are not viable.

Harvest Prescriptions

Under some alternatives non-clearcut prescriptions are employed in stand conditions not typically harvested in that fashion under current practise. Consequently, implementation of non-clearcut treatments, as scheduled in certain stand types under some alternatives, may require some operational experimentation to perfect.

Further, and by necessity, the suitability of stands for non-clearcut harvesting was assessed solely from stand descriptions derived from forest inventory information. This provides an informative but somewhat generalized view. Specific conditions are all-important in governing treatment suitability at the stand level where harvest implementation occurs. Suitability assessment for non-clearcut harvesting will require thorough on-site evaluation of stand conditions; as a result the abundance of suitable area may differ from what is estimated here.

Catastrophic Loss

None of the analyses include accounting for catastrophic loss, as might be caused by wildfire, insect outbreaks, or windstorm. Protection against fire and insect losses has been an integral part of New Brunswick's forest management and has been reasonably successful in limiting such losses. All indications are that it will continue to be so, and in the event excessive losses do occur, the common approach is to respond via salvaging those losses and redesigning management strategies in light of them.

Climate Change

Climate change is an issue with potentially serious impacts on the forest. Although the Task Force consulted experts on forest impacts of climate change, the complexity and uncertainty surrounding the topic's many facets prevented its explicit inclusion in the analyses.

It can be considered in an indirect and incomplete way, however. Experts consulted by the Task Force agree that, especially in southern New Brunswick, tolerant hardwood species, white pine, and red spruce are likely to fare better under anticipated climate change than will balsam fir and black spruce, although this advantage will materialize gradually over time. Thus, alternatives that increase the abundance of better-suited species, and decrease that of less well-suited ones, will likely result in a forest better able to grow and thrive under the anticipated climate of the future.

Steps in this direction can begin in the short-term through strategies that favour regeneration of the better-suited species, either by appropriate choice of harvest prescription to regenerate them naturally, or by appropriate choice of species and genotype to regenerate them through planting.

Beyond that, current science suggests that:

- stand yields will change (as influenced by both positive and negative factors, such as increased growing degree days and increased drought, respectively);
- the incidence of fire and insect/disease outbreaks may increase;
- regeneration patterns following disturbance may change resulting in different species compositions.

Most of these changes are likely to develop gradually over time and the forestry community must be alert to them and be ready to revise management strategies as understanding of impacts improves.

Unmeasured Socio-economic Impacts

Part of the Task Force mandate was to address the economic aspect of forest management in terms of wood-based products manufacturing. The forest provides numerous other economic benefits, including those relating to eco-tourism, consumptive and non-consumptive recreation, non-timber forest products, bio-energy, and, potentially, carbon.

To a limited extent, impacts of management alternatives on these economic aspects can be inferred from the forest conditions forecast under each alternative. However, more complete and explicit consideration of them should be made when evaluating the desirability of various alternatives.

Furthermore, there are many social implications of forest management and its results that are not presented here. These include matters like aesthetic and spiritual values, perception of risk, and inter-generational equity. Their absence here reflects the difficulty in describing them in clear and objective terms, not their relative importance as factors to consider in choosing an appropriate forest management strategy.

Ecological Services

In an attempt to be objective and clear, the alternatives' outcomes are presented using indicators readily measured and quantified. Other important outcomes are less easily quantified and do not appear here in explicit terms. For example, no direct measures are provided for important ecological services, including such things as:

- water and air protection and purification;
- prevention of soil erosion;
- control of water run-off and water table recharge;
- cycling of nutrients; and
- decomposition.

Although much progress is being made in quantifying such services, the Task Force felt that current methods could not be properly and adequately applied given the time and resources available for this effort.

Further, all alternatives are based on continued presence of forest cover on the current forested landbase. There are no land-use decisions at play (e.g. converting forest to agricultural or residential or hydro-electric use), and no shrinkage of forest area, to which many ecological services are most sensitive.

Inferences about some ecological services like maintenance of diversity, provision of habitat, protection of water (through existence and size of riparian buffers) can be readily made given the forest descriptions provided here.

Finally, like the unmeasured social impacts of forestry, the absence of direct measures here does not suggest a lack of importance.

Management Flexibility

To obtain a long-term view of management impacts and to evaluate sustainability, forecasts of forest development must be made over a long time horizon. Obviously, there exist many unknowns about the future, and over that time frame unpredictable changes will occur in economic conditions, environmental conditions, forest products markets, and social values and preferences.

This raises two points. First, adaptation to such changes is partly accommodated in forest management by regular and frequent replanning in which strategy adjustments are made in response to unfolding reality. Thus, there exists a mechanism to adjust management given the uncertainty inherent in planning for the future, and this will continue as a standard part of the forest management procedures for Crown land, regardless of what strategy is implemented.

Second, the effectiveness of management adjustment is partly controlled by the degree of flexibilty afforded by the condition of the forest. Here flexibility can be viewed as the degree to which realization of new objectives is restricted by the forest condition that exists as a result of pursuing past and current objectives. Important options may be foreclosed where restriction of new objectives is high.

There is no single forest condition that affords maximum flexibility to accommodate change, and views are likely to vary between interested parties as to what condition does so. Regardless of how one perceives flexibility, the existence of certain, but unknowable change makes flexibility an important consideration in evaluating management alternatives.

Final Note

Forest management is all about taking measures now to create a forest that will be economically valuable, ecologically healthy, and socially desirable in the future, while deriving economic, environmental and social benefit from the forest today. While most would accept this as an unassailable objective, opinions will vary as to how best to accomplish it. There is no one right answer.

As clearly revealed by the analyses presented here, not all benefits can be simultaneously maximized; measures to enhance some benefits will negatively affect others. The resulting trade-offs cannot be avoided but they should be explicitly recognized, and consciously factored into management decisions. The decision-making challenge is to thoroughly evaluate possibilities and implement a management strategy that provides the best balance of benefits through time. The Task Force hopes this report assists the Province in that important and formidable task.

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Glossary

annual allowable cut	Volume of timber that may be harvested during a given period to maintain sustained production.
biological diversity	The diversity of plants, animals, and other living organisms in all their forms and levels of organization, including genes, species, ecosystems, and the evolutionary and functional processes that link them.
boreal forest	The broad band of forest that extends across northern Canada above the 49° parallel and is dominated by white and black spruce, jack and lodgepole pine, balsam fir, trembling aspen, balsam poplar, and white birch.
coarse woody debris	Dead, woody material (usually >8cm or so in diameter) lying on the forest floor in various stages of decomposition.
deciduous forest	The area of forest east and south of the Great Lakes dominated by oak, maple, hickory and pine genera.
ecological legacies	Structures or organisms left on site following a disturbance which play an important role in post-disturbance recovery and development.
even-aged management	Managing a stand by creating large, stand replacing disturbances to establish by natural or artificial regeneration a new stand of trees with a very narrow range of ages (e.g. clearcut harvesting).
gap replacing disturbance	Relatively small openings (one or two tree heights) in the forest canopy created by the death of a small number of overstory trees. Regeneration frequently establishes in these openings, creating over time a stand with trees of multiple ages.
geophysical	Abiotic factors relating to soil, water, climate, and topography.
hardwood	Broadleaf tree species, including (in N.B.) birches, maples, poplars, oaks, ashes, butternut, cherry, and ironwood.
intolerant (shade)	An inability to grow at low light levels. In the general sense, "tolerance" can refer to any ecological factor, not only light.
late-successional	Tree species which dominate in stands which have undergone long periods of natural development without major disturbance. Most tend to be very long-lived, shade tolerant, and regenerate following gap disturbances. In this report, the term includes sugar maple, eastern hemlock, eastern cedar, red spruce. Also included, but less tolerant and not restricted to gap disturbances are white pine, red pine, and yellow birch.
natural disturbances	Natural forces or agents which kill trees in a stand, creating opportunity for regeneration of new individuals. Normally does not include death of trees from between-tree competition for resources.

non-native species	Species not naturally found within a defined geographic area.
pre-commercial thinning	See spacing.
rotation	The planned number of years between the formation or regeneration of a crop or stand and its final cutting at a specified stage of maturity.
senescence	The phase of development in a stand where much of the overstory trees begin to die of old age, resulting in an opening up of the canopy and regeneration of new trees in the openings.
snags	Standing dead trees.
softwood	Needle-bearing tree species including (in N.B.) spruces, pines, balsam fir, hemlock, cedar, and larch.
spacing	A cutting, yielding no commercial volume, made in an immature stand of trees primarily to accelerate diameter increment, control species composition, and improve spacing between trees.
stand	A spatially contiguous community of trees possessing sufficient uniformity in composition, age, arrangement, or condition to be distinguishable from the forest or other growth on adjoining areas, thus forming a silvicultural or management entity.
stand replacing disturbances	Relatively large openings, 1/2 to many hectares, created by the death of most overstory trees. Frequently result in regeneration of an even-aged stand of species well-adapted to open conditions (e.g. balsam fir and intolerant species).
tolerant (shade)	An ability to grow at low light levels. In the general sense, "tolerance" can refer to any ecological factor, not only light.
uneven-aged management	Managing a stand by periodically creating small gap openings to establish multiple age classes of trees within the stand (e.g. single-tree selection harvesting).
unmanipulated	Stands in which no harvesting has occurred subsequent to 1930 (including forecast years beyond the present).

Appendices

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Appendix 1

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Appendix 3

Stand Type Composition

The composition of each stand type was calculated by dividing the volume of individual tree species into the total volume for that stand type at age 50. Based on these percentages, the algorithm presented below was used to sort each stand type into fine, and then broad stand types.

Broad Stand Type	Fine Stand Type	Criteria[1]
Balsam Fir (BFIR)	Balsam Fir- Spruce (BFSP)	SW > 70% and BF > SP
Spruce-Balsam Fir (SPBF)	Spruce- Balsam Fir (SPBF)	SW > 70% and SP > BF
Spruce-Balsam Fir (SPBF)	Black Spruce (BS)	SW > 50% and BS > 30%
Tolerant Softwood (TOSW)	Eastern Cedar (EC)	SW > 50% and EC > 30%
Tolerant Softwood (TOSW)	Eastern Hemlock (EH)	SW > 50% and EH > 30%
Tolerant Softwood (TOSW)	Red Spruce (RS)	SW > 50% and RS > 30%
Jack Pine (JP)	Jack Pine (JP)	SW > 50% and JP > 30%
Pine (PI)	Pine (PI)	SW > 50% and WP + RP > 30%
Tolerant Mixedwood (THMX)	Spruce/Fir-Tolerant Hardwood (SFTH)	SW > 50% and TH > 20% and TH + RM > 30%
Tolerant Mixedwood (THMX)	Tolerant Hardwood-Softwood (THSW)	SW < 50% and TH > 20% and TH + RM > 30% and < 70% and TH > RM
Intolerant Mixedwood (IHMX)	Intolerant Hardwood-Softwood (IHSW)	SW < 50% and not TH and not THSW
Intolerant Mixedwood (IHMX)	Spruce/Fir-Intolerant Hardwood (SFIH)	SW > 50% and not SFTH
Tolerant Hardwood (TOHW)	Pure Tolerant Hardwood (TH)	SW < 50% and TH > 20% and TH + RM >70%

1 Criteria are defined as percent of merchantable volume and are applied to each stand type. SW = softwood, WP = white pine, RP = red pine, JP = jack pine, EC = eastern cedar, EH = eastern hemlock, RS = red spruce, BS = black spruce, BF = balsam fir, SP = spruce, TH = tolerant hardwood, RM = red maple.

Appendix 4

Forest Area by Management Zone and Species Composition

The initial total Crown forest area used in the analysis is described below in terms of the history of stand management, stand composition and management zone. The initial year was set to the start of the next 5-year planning cycle, i.e. 2012, and the forest condition was updated for activities scheduled for implementation between 2008 and 2012. Note the two legends that describe the definitions of the labels used in the area descriptions.

Mgmt.	General Forest (1000s ha)				Habitats (1000s ha)				Slope/Inoperable/PNA (1000s ha)				All Forested Land (1000s ha)			
Hist.	T1	T2	T3	TOTAL	T1	T2	T3	TOTAL	T1	T2	T3	TOTAL	T1	T2	T3	TOTAL
NAT	128.9	89.8	446.7	665.4	142.2	80.1	348.8	571.1	36.6	27.8	125.1	189.4	307.7	197.7	920.6	1425.9
NATr	7.3	100.4	361.3	469.0	0.6	10.6	52.1	63.2	0.1	3.8	15.4	19.3	8.1	114.7	428.7	551.5
PAR	121.1	39.2	4.4	164.6	34.0	10.0	0.1	44.1	6.2	3.7	0.0	9.9	161.3	52.8	4.5	218.7
PCT	38.9	38.9	311.2	389.0	2.7	2.7	21.6	27.0	0.5	0.5	3.8	4.7	42.1	42.1	336.6	420.8
PLT	7.1	10.6	335.1	352.7	0.4	0.6	18.7	19.7	0.1	0.1	2.9	3.1	7.5	11.3	356.7	375.5
TOTAL	303.3	278.9	1458.7	2040.8	179.9	104.0	441.4	725.3	43.4	35.8	147.2	226.4	526.6	418.6	2047.2	2992.5

Mgmt.	General Forest (% of total area)				Habitats (% of total area)				Slope/Inop./PNA (% of total area)				All Forested Land (% of total area)			
Hist	T1	T2	T3	TOTAL	T1	T2	T3	TOTAL	T1	T2	T3	TOTAL	T1	T2	T3	TOTAL
NAT	4.3	3.0	14.9	22.2	4.8	2.7	11.7	19.1	1.2	0.9	4.2	6.3	10.3	6.6	30.8	47.7
NATr	0.2	3.4	12.1	15.7	0.0	0.4	1.7	2.1	0.0	0.1	0.5	0.6	0.3	3.8	14.3	18.4
PAR	4.0	1.3	0.1	5.5	1.1	0.3	0.0	1.5	0.2	0.1	0.0	0.3	5.4	1.8	0.2	7.3
PCT	1.3	1.3	10.4	13.0	0.1	0.1	0.7	0.9	0.0	0.0	0.1	0.2	1.4	1.4	11.2	14.1
PLT	0.2	0.4	11.2	11.8	0.0	0.0	0.6	0.7	0.0	0.0	0.1	0.1	0.3	0.4	11.9	12.5
TOTAL	10.1	9.3	48.7	68.2	6.0	3.5	14.7	24.2	1.5	1.2	4.9	7.6	17.6	14.0	68.4	100.0

Management History Legend

Code	Description
NAT	Area showing no evidence of harvest in past 35 years
NATr	Area harvested with even-aged treatment with no silvicultural follow-up
PAR	Area having been partially harvested within past 25 years
PCT	Area spaced
PLT	Area planted

Species Composition Category Legend

Code	Description[1]
T1	RS + EC + EH + WP + RP + SM + YB + O + WA > 50% or > 40% with RM > 10%
T2	not T1 and RS + EC + EH + WP + RP + SM + YB + O + WA > 30% or > 20% with RM > 10%
T3	not T1 and not T2 (key species < 20%)

1 RS = red spruce, EC = eastern cedar, EH = eastern hemlock, WP = white pine, RP = red pine, SM = sugar maple, YB = yellow birch, O = oak, WA = white ash, RM = red maple

Appendix 5

Dimension-based Timber Categories by Species Group

Stand-level timber volume projections were defined in terms of dimension size classes (based on length and top diameter specifications) for each species. The table below describes the dimension size classes, species groupings and log-potential categories that were used for the wood supply indicators employed in the analyses.

			Softwood Species		
Size class	Top Diameter (cm ob[1])	Length (m)	Spruce/fir	White Pine	Cedar
16' large diameter log	26	5.05	Log-potential	Log-potential	Log-potential
16' medium diameter log	18	5.05			
8' medium diameter log	18	2.55			
8' small diameter log	12	2.55			
8' pulpwood	8	2.55			
merchantable top	8	< 2.55			

			Hardwood Species		
Size class	Top Diameter (cm ob)	Length (m)	Tolerant Hardwood	Intolerant Hardwood	Poplar
8' large diameter log	26	2.55	Log-potential	Log-potential	Log-potential
8' medium diameter log	20	2.55			
8' small diameter log	15	2.55			
8' pulpwood	8	2.55			
merchantable top	8	< 2.55			

1 ob = outside bark

Appendix 6

Treatment Summary

Harvest Type[1]	Description	Objective	Residual Target Conditions	Prescription	Dist. Type	Retention[2]	Treatment Cost[4]
Even-aged Harvest Treatments							
Shelterwood (Non-CC)	• spatially distributed partial harvest of merchantable overstory • targeted retention of species sought as regeneration	• volume recovery • establish even-aged regeneration of desired species	• stable partial overstory • seedbed and light suitable for regeneration of desired species	• spatially distributed 40% vol removal • target low vigour & short-lived species	stand	yes	$32/m³
Clearcut (CC)	• clear felling all merchantable stems of all species	• volume recovery • regenerate even-aged stand naturally or by planting	• protected advance natural regeneration OR • suited for site prep and planting	• harvest of all commercial stems • protection of advance regeneration if of desired species and quality	stand	yes	$28/m³
Commercial Thinning (Non-CC)	• spatially uniform partial harvest of merchantable stems in immature stand	• concentrate growth on crop trees • early volume recovery • pre-empt mortality	• well spaced stems • near full stocking	1st pass • 33% removal • 15 yrs to re-entry 2nd pass • 30% removal from below	n/a	no	1st $40/m³ 2nd $32/m³
Strip &Group Selection (Non-CC)	• area-based partial harvest of overstory in small groups or narrow regular strips • relatively short re-entry interval	• volume recovery • regenerate even-aged stand naturally • extend presence of overstory canopy	• stable unharvested overstory • seedbed and light suitable for regeneration of desired species	• 50% of area harvested in strips or groups • clearfell of all stems within harvested area • re-entry to harvest next 50% in 10 years	stand	yes	$34/m³
Uneven-aged Harvest Treatments							
Strip &Group Selection (Non-CC)	• area-based partial harvest of overstory in small groups or narrow regular strips • relatively long re-entry interval	• regenerate tolerant, semi-tolerant and late successional species • volume recovery & promote high grade • create/maintain multi-aged stand & mature overstory	• partial mature canopy coverage within stand • seedbed and light suitable for regeneration of desired species in harvested gaps	• 33% of area harvested in strips or groups • clearfell of all stems within harvested area • re-entry to harvest next 33% in 30 years	gap	yes	$36/m³
Juvenile Stand Treatments							
Planting	• planting of pure species and species mixtures	• achieve full site utilization by desired species	• density of 2000-2400 trees/ha	• plant in rows of desired spacing	n/a	n/a	$990/ha
Spacing	• softwood or hardwood-oriented spacing in naturally regenerating stands	• reduce inter-tree competition • focus growth on desired species	• density of 2000-3500 trees/ha	• space to desired density favoring late-successional trees of high quality and vigor	n/a	n/a	$726/ha

1 Treatments deemed to emulate natural disturbance include (a) uneven-aged treatments conducted in stand types prone to gap disturbance and (b) even-aged treatments with at least 10% retention in stand types prone to stand-replacing disturbance.

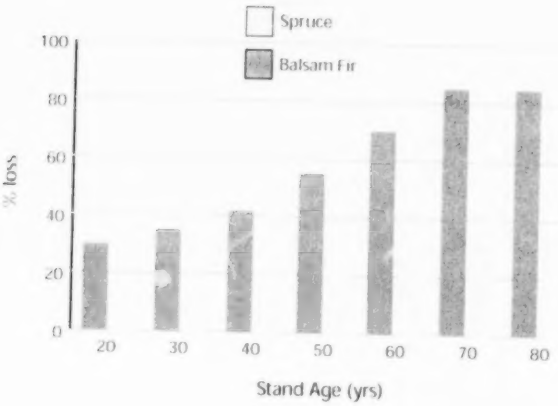
2 Permanent structural retention designed to provide within stand structural diversity, and future supply of snags, and coarse woody debris. Retention is set to between 0 and 20% of stand, depending on treatment alternative. Aggregate retention with proportional representation of all species and size classes is assumed.

4 Harvest treatment costs are roadside costs, which include costs of felling, processing and forwarding to roadside. Overhead costs are also included to account for planning, administering and supervising harvest operations, including road construction and maintenance. Not included in treatment costs are transportation costs, which were assumed to be an additional $10/m³. Planting costs include planting stock, plantation establishment (plus 10% for improved stocking) and herbicide costs.

Appendix 7

Potential Spruce Budworm Losses

Potential losses to spruce budworm were calculated using the age-dependent volume loss relationships presented below. The percent of volume lost represents the potential losses that might occur under a severe outbreak with no protection.



Derived from MacLean, D.A. 1980. Vulnerability of Fir-Spruce stands during uncontrolled spruce budworm outbreaks: A review and discussion. Forestry Chronicle. 56(5):213-221.

Appendix 8

Mature and Late Successional Forest Criteria

Mature and late-successional forest conditions were projected for each stand type based on the tree age and stand structural criteria presented below. Structural criteria were defined by basal area of stems larger than 10 centimeters at breast height (DBH), and by the density of live and dead stems of varying size at breast height.

Table 1. Stand Structure criteria used to define Mature and Late-successional forest.

Condition	Basal Area stems >10cm (m²/ha)	Density (stems per ha)						
		≥ 10cm dbh	≥ 30cm dbh		≥ 46cm dbh		≥ 60cm dbh	
		Dead	Live	Dead	Live	Dead	Live	Dead
Mature								
Tolerant Hardwood	≥ 18 all species ≥ 14 TH	≥ 20	≥ 60	≥ 15	≥ 0.25	≥ 0.5		
Hardwood	≥ 18 all species ≥ 14 HW	≥ 20	≥ 60	≥ 15				
Spruce/fir	≥ 18 all species ≥ 14 SW	≥ 20	≥ 10	≥ 10				
Pine	≥ 18 all species ≥ 12 PINE		≥ 20 Pine	≥ 3.3 Pine				
Mixedwood	≥ 18 all species		≥ 60	≥ 3.3				
Late-successional (LSF)								
Tolerant & long-lived species					≥ 100	≥ 30	≥ 5	≥ 1
OR	30% > LSF age (Table 2)							
Intolerant & short-lived species			≥ 200	≥ 50	≥ 5	≥ 1		
OR	30% > LSF age (Table 2)							

Table 2. Minimum ages for late-successional forest criteria.

Softwood Species	Minimum Late-successional Age (yrs)	Hardwood Species	Minimum Late-successional Age (yrs)
black spruce	110	beech	150
white spruce	110	sugar maple	150
red spruce	140	red maple	110
balsam fir	70	yellow birch	150
jack pine	110	other HW	110
white pine	150	white birch	70
red pine	140	poplar	70
eastern cedar	140		
eastern hemlock	140		
larch	110		

Appendix 9

Conversion Factors for Converting Merchantable Volume to Carbon

The conversions presented in the table below were used to convert the forest-level inventory of merchantable timber volume to stored carbon.

Step	Multiply	By	To Calculate
1	Inside bolewood (merch. vol in m^3)	1.454	Total above-ground wood volume (bark, branches and tops in m^3)
2	Inside bolewood (merch. vol in m^3)	0.396	Below-ground wood volume (m^3)
3	Total wood volume (above and below-ground in m^3)	0.43	Dry biomass (tonnes)
4	Dry biomass (tonnes)	0.5	Carbon (tonnes)

Derived from : von Mirbach, M. 2000. Carbon Budget Accounting at the Forest Management Unit Level. Canada's Model Forest Program. Natural Resources Canada. Canadian Forest Service. Ottawa, Ontario.

Appendix 10

Data and Assumptions for Socio-economic Indicators

Government Royalty Rates

The table below presents the royalty rates charged for timber harvested from Crown land. The rates are based on values current to September 2007.

Class of Timber	Softwood Species Group	Royalty Rate	Hardwood Species Group	Royalty Rate
Sawlogs	White pine	$17.57/m³	Poplar	$9.57/m³
	Red pine	$5.69/m³	Sugar maple	$21.77/m³
	Cedar	$12.53/m³	Yellow birch	$20.07/m³
	Hemlock and larch	$5.69/m³	White birch	$18.05/m³
	Spruce-fir-jack pine	$16.98/m³	Other hardwoods	$16.56/m³
Select Sawlogs[1]			Sugar maple	$60.23/m³
			Yellow birch	$45.40/m³
			Other hardwoods	$36.08/m³
Veneer Logs	White pine	$33.87/m³	Sugar maple	$60.23/m³
	Spruce-fir-jack pine	$25.96/m³	Yellow birch	$45.40/m³
	Other softwoods	$15.25/m³	Poplar	$13.29/m³
			Other hardwoods	$36.08/m³
Pulpwood	Spruce-fir-jack pine	$3.38/m³ [2]	All hardwood	$3.68/m³
	Other softwoods	$2.49/m³		
Poles	Red pine	$27.89/m³		
Shinglewood	Cedar	$7.98/m³		

1 Select sawlogs are assumed to be 9% of total sawlog production.
2 Average price of kraft ($2.49/m³) and groundwood ($4.26/m³) pulpwood.

Employment Factors

The table below presents factors used to convert hectares (for silviculture) and millions of cubic metres harvested (for logging and manufacturing) to jobs. Future improvements in productivity in the logging, wood products manufacturing and pulp and paper sectors were assumed, and are presented here for the first two forecast periods. Values are calculated in terms of jobs (not person years), since much of the employment associated with the silviculture program is seasonal (lasting 6- 22 weeks). Employment factors were derived by Dr. Raj Chaini, researcher at the Canadian Forest Service - Atlantic, in Fredericton, NB.

Sector	Conversion (yrs 1-5)	Conversion (yrs 6-10)
Silviculture – planting	0.03726 jobs/ha[1]	0.03726 jobs/ha[1]
Silviculture – spacing	0.0401 jobs/ha[2]	0.0401 jobs/ha[2]
Logging	347.9 jobs/million m³	327.1 jobs/million m³
Wood Products Manufacturing	702.6 jobs/million m³	686.5 jobs/million m³
Pulp and Paper	592.5 jobs/million m³	571.0 jobs/million m³

1 This value includes all employment required for the planting program, including planting, planting overhead, site preparation, the herbicide program and nursery employment. Planting overhead includes planter supervision, surveying and other management activities involved in the planting program.
2 This value includes all employment required for the spacing program, including spacing and spacing overhead. Spacing overhead includes spacing supervision, surveying and other management activities involved in the spacing program.

Product Prices

The table below presents prices used to calculate shipment values. Future changes in prices are assumed and are presented here for the first two forecast periods. Product prices were approximated based on trends projected by forest products market analysts.

Product		Price (yrs 1-5)	Price (yrs 6-10)
Softwood	Pulp	$876.24/metric tonne	$896.54/metric tonne
	Lumber	$321.68/1000 board feet	$436.28/1000 board feet
	Veneer	$336.68/1000 sq ft	$451.28/1000 sq ft
Hardwood	Pulp	$772.24/metric tonnes	$792.54/metric tonne
	Lumber	$600.68/1000 board feet	$715.28/1000 board feet
	Veneer	$616.68/1000 sq ft	$731.28/1000 sq ft

Appendix 11

Estimation of Pre-1940 Forest Composition

The following process was used to estimate the abundance of stand types in the New Brunswick Crown forest just prior to 1940, which predates the era of industrial forestry practises.

[1] Assign forest community designation to each of 10000 forest development survey (FDS) inventory plots using criteria defined in Appendix 3. This assignment of "community" includes no photo-interpretation error in defining stand composition, as it is based on ground observation.

[2] Each plot was also assigned a forest unit name based on photo-interpreted species composition. This assignment of "forest unit" does include stand composition error resulting from interpretation of aerial photography.

[3] Calculate by ecoregion and ecosite the percent of plots in each forest unit that fall in each community. This "corrects" for photo-interpretation error in assigning forest unit.

[4] Relate the stand inventory file to the FDS inventory plot file by ecoregion, ecosite, and forest unit. Then prorate each stand's area by the percent of its forest unit that is in each community (as defined in step [3]).

[5] Extract from the stand inventory file, only those stands classified as "mature" (M) or "overmature" (O); and for each ecodistrict disturbance group and ecosite calculate the percent area by community (illustrated for the gap disturbance group below).

EcoSite	% Area of M and O stands by Ecosite and Community for Ecodistricts where Gap Natural Disturbances Predominate												
	BFSP	BS	EC	EH	IHSW	JP	PINE	RS	SFIH	SFTH	SPBF	TH	THSW
1	0.0	20.0	11.6	1.4	7.9	0.2	0.0	28.2	19.3	0.0	2.9	1.4	7.2
2	0.6	21.2	8.7	3.8	12.5	0.1	0.1	33.1	8.4	0.0	3.7	3.1	4.6
3	1.8	31.5	14.5	3.1	11.6	0.0	0.3	11.1	13.4	0.0	3.3	4.2	5.3
4	0.4	1.4	0.9	0.0	4.4	0.0	0.0	39.7	18.0	0.0	0.7	22.9	11.6
5	0.8	7.2	9.8	3.9	7.5	0.0	0.1	32.7	8.8	0.3	3.2	15.5	10.2
6	1.1	22.6	32.9	1.4	9.2	0.0	0.1	16.8	7.1	0.0	4.7	1.3	2.8
7	0.3	9.3	5.5	2.2	6.8	0.0	0.1	18.2	5.7	0.7	0.1	35.5	15.5
8	2.7	0.7	1.6	0.3	5.9	0.0	0.0	7.2	8.4	0.0	0.0	65.9	7.2

Since most mature and overmature stands in the 2000 inventory are older than 60 years, they generally originated prior to 1940. They thus represent the pre-1940 forest condition and are assumed to be relatively uninfluenced by practices of the types carried out over the last few decades.

[6] Summarize from the stand inventory the absolute area in each ecodistrict disturbance group by ecosite.

[7] Multiply Table 1 percentages by areas summarized in step [5]. This results in the area which would fall into each broad community in pre-1940 (if all of the assumptions in this process hold).

[8] Comparing the present distribution of area by broad community to this result gives some indication of relative increases and decreases in community abundance.

Appendix 12

Species Adapted to Future Climate

The following table was assembled by researchers at the Canadian Forest Service (personal communication, Dr. Mike Lavigne, Atlantic Research Centre, Canadian Forest Service, Fredericton, NB). It summarizes their views on how forest composition should change in order to create a forest condition that is more capable of withstanding future changes in climate.

	Suggested Changes to Forest Community Area By Ecoregion						
Fine Forest Community (see Appendix 3 for definitions)	Ecoregion 1	2	3	4	5	6	7
Balsam fir-Spruce	0	–	–	–	-2	-2	-2
Black spruce	0	–	–	–	-2	–	-2
Eastern cedar	0	0	0	0	0	0	0
Eastern hemlock	0	0	0	0	0	0	0
Intolerant hardwood-softwood	0	+	+	+	+	+	+
Jack pine	0	–	–	–	–	–	–
Pine	0	+	+	+	+	+	+
Red spruce	0	+	+	+	+	+	+
Spruce-Balsam fir-intolerant hardwood	0	–	–	–	–	–	–
Spruce-Balsam fir-tolerant hardwood	0	–	–	–	–	–	–
Spruce-Balsam fir	0	–	–	–	-2	-2	-2
Spruce-tolerant hardwood	0	0	+	+	+	+	+
Tolerant hardwood	0	+	+	+	+	+	+
Tolerant hardwood-softwood	0	+	+	+	+	+	+

+ = increase, 0 = no change required, – = decrease, -2 = decrease more urgently

Appendix 13

Harvest Eligibility by Disturbance Type

Each stand type was evaluated for its eligibility to receive each of the harvest treatments in the table below. Eligibility means the possibility is created for a particular type to receive a harvest treatment; whether the stand type is treated by the harvest type for which it is eligible depends on the objectives of the forest-level strategy being examined. Note that all stand types are eligible for clearcutting, but those represented in the "clearcut" row in the table below are the stand types that are not eligible for one of the non-clearcut treatments. The area of stand types eligible for each treatment is summarized below in terms of the dominant natural disturbance tendency for the ecodistrict within which the stand types exist.

Harvest Type	Area (1000 ha)					Area (%)				
	Gap	Gap-Stand	Stand-Gap	Stand	Total	Gap	Gap-Stand	Stand-Gap	Stand	Total
Clearcut	78	184	491	599	1351	34	38	45	50	45
Even-aged Strip	15	30	132	205	383	7	6	12	17	13
Shelterwood	19	52	157	173	401	8	11	14	15	13
Uneven-aged Group Selection	117	218	309	214	858	51	45	28	18	29
All	229	483	1088	1192	2992	100	100	100	100	100